Statement of Work for

"Algorithm, Adapters, and Data Distribution for the Visible Human Project Insight Toolkit"

General

The National Library of Medicine (NLM) seeks to promote and extend Insight, its open-source software initiative in image processing tools. The NLM application programmers interface (API), known as the Insight Toolkit (ITK), is the core of this software development project. NLM is seeking proposals for (A) algorithm validation data collection and data processing (with a focus on time-varying data applications such as longitudinal data collections on chronic, degenerative diseases) as well as tools for managing public data collections; and/or (B) contract programming that extends ITK through incorporating additional algorithm families not already represented in ITK or projects that incorporate ITK into software and hardware systems in support of clinical applications (with an emphasis on multidisciplinary, multi-scale, practical applications). The validation data component will emphasize the assembling of test data, including implementation of existing statistical methods and generation of ground truth segmentations, provided that all examples, data, and software tools are compatible with the existing ITK software base. Individual ITK development projects under this procurement should not exceed $100,000 in cost nor surpass 1 year in duration. Proposals should not exceed five (5) pages, covering: (i) the purpose of the proposed work; (ii) the relationship and benefits of the project to the ITK effort; (iii) the advantages that the proposed work derives from ITK; (iv) how the proposed work differs from existing work in ITK and its related software; (v) the personnel and resources to be committed to the proposed work; and (vi) a budget for the work. A single offeror or institution may submit multiple project proposals for different deliverables, providing each proposal is a separate and discrete software development project. Multiple awards are anticipated, and a single P.I. may receive more than one award.

All proposals are limited to five (5) letter size (8 1/2 by 11 inches) pages, with 3/4 inch margins and a minimum font size of 10 points. Submissions will be accepted in electronic format only, in PDF format. Any additional information submitted cannot exceed fifteen (15) pages, and will only be considered supplemental reference material for information only and technical evaluators are not required to read the material. Any proposal not complying with these specifications will not be considered.

Background

In 1989, the NLM Board of Regents empowered an ad hoc panel of experts to recommend the position that NLM should embrace the rapidly evolving field of electronic imagery. In August of 1991, the University of Colorado School of Medicine was awarded a contract resulting in the acquisition of the NLM Visible Human Project Male and Female (VHP) datasets. NLM then made the datasets available under a no-cost license agreement over the Internet. The VHP male dataset contains 1,971 digital axial anatomical images obtained at 1.0-mm intervals (15 Gbytes), and the VHP female dataset contains 5,189 digital images obtained at 0.33-mm intervals (39 Gbytes). Since the introduction of the data sets and initial licensed use by over 1000 Worldwide participants, three VHP Conferences have been hosted by the NLM. These Conferences have highlighted the importance of sponsoring development of applications of the Visible Human Project.

Researchers working with the Visible Human Project data have continued to create new opportunities for additional anatomical and medical exploration. However, researchers have complained that they are "drowning in data," due in part to the sheer size of the image information and the available anatomical detail. In addition, the imaging community continues to request data with finer resolution, a suggestion that will only compound the existing problems posed by large data on data navigation and visualization. The National Library of Medicine and its partner institutes and agencies are seeking a broadly accepted, lasting response to the issues raised by the segmentation and registration of large 3D medical data.

In 1999, the NLM Office of High Performance Computing and Communications awarded multiple contracts for the formation of a software development consortium to create and develop an application programmer interface (API) and first implementation of a segmentation and registration toolkit, subsequently named the *Insight Toolkit* (ITK). The resulting system is designed to be suitable for computer-assisted exploration of the National Library of Medicine (NLM) Visible Human (VHP) Male and Female data sets. The final deliverable product of this group is to be beyond a beta prototype stage, compatible for direct insertion into the public domain via Internet access through the NLM or its licensed distributors.

Ultimately, we hope to sponsor the creation of a public segmentation and registration software toolkit as a foundation for future medical image understanding research. The intent is to amplify the investment being made through the Visible Human Project and future programs for medical image analysis by reducing the reinvention of basic algorithms. We are also hoping to empower young researchers and small research laboratories with the kernel of an image analysis system in the public domain. The NLM is partnered with other National Institutes of Health and Federal Agencies: the National Institute for Craniofacial and Dental Research; the National Eye Institute; the National Institute for Mental Health; the National Institute for Neurological Disorders and Stroke; the National Institute on Deafness and Other Communication Disorders; the National Cancer Institute, the National Science Foundation, and the DoD Telemedicine and Advanced Technology Research Center. An objective of NLM and its partner Institutes and Centers (ICs) is to support a research and development project that forms prototypes for advanced applications based on the VHP data sets and other possible clinical images.

Scope

The Insight Toolkit (ITK) is currently under development, with its fifth release ITK 1.8 publicly available online (see the URL: http://www.itk.org). The current contracts provide for some basic documentation, examples, and other supplementary software and materials that are required elements for a self-sustaining software development effort.

The purpose of this procurement is to obtain contract development services in support of the Insight Toolkit (ITK), the image processing tools initiative of the Visible Human Project. This project will focus on the acquisition of additional 3D (or higher dimensional) image processing, segmentation, and registration algorithms for ITK, as well as target the development of applications, connecting ITK to existing medical visualization, surgical planning, and other clinical needs. Projects must reflect existing methods and cannot have significant risk related to unproven science or mathematics.
In addition, NLM is seeking data, suitable for supporting algorithm validation experiments and as input for ITK examples, with intention of distributing this data through the same public channels as the ITK software. The NLM is placing an emphasis on multiscale, multidisciplinary data (such as sensor data that augments volumetric images) as well as time-varying data from longitudinal studies for clinical trials on chronic degenerative diseases or developmental data associated with neural tract

imaging and child development.

Multiple awards are expected, and a single group or offeror may receive more than one award for separate and discrete software development proposals. Individual projects are limited to one year in duration and a maximum of $100,000.

Description of Services

Integration is considered the key to success for both this contract action as well as the success of the ITK toolkit in general. All offerors should be prepared to work closely with other NLM contractors and with the existing Insight software community. All software deliverables will be checked-in to the current source code control system and vetted through the style checker and regression testing dashboards currently in place.

All deliverables will reside in the public domain (either through controlled Internet distribution from the NLM or through a third party electronic publisher), including all source code. As with the VHP data, controlled access to the source code and image processing tools will be through the issuance of no-cost licenses. The licenses are required solely to allow NLM to track the use, distribution, and proliferation of VHP program products. The eventual software developers will be held to high software standards, and extensive documentation for the software tools (including tutorials, manuals, and examples) are required.
To meet the fairly rigorous demands of this collaborative software development project, in the case of algorithm-contributing contractors and software interface developing contractors, NLM is applying the following technical requirements:

- Strong knowledge of C++ object-oriented programming.
- Demonstrated experience with existing software either being ported to ITK or being adapted through a system interface.
- Commitment to all software and documentation developed under these contracts being made available as open-source material.
- Commitment to developing software under this contract under the style rules and architectural design of the Insight Toolkit.

The NLM encourages relationships between industry and academia in this development process. A FTE commitment for programming staff from each of the parties in the consortium is essential.
Since public distribution of all data and software is a fundamental principle of this project, in the case of data-contributing contractors, NLM requires that the contractor demonstrate, through the text of the proposal, a knowledge and understanding of the issues in distributing medical data including: the use of patient release forms for long-term authorization of data distribution; the scrubbing of metadata to protect patient privacy; and the reformatting of datasets to comply with standard forms of data files for use in medical software applications.

Subordinate tasks or types of work.

The contractor will be required to complete the following tasks or prepare the following deliverables:

1. Attend a contractor meeting (at NIH or some other mutually acceptable designated location). The contract PI is required to attend and may bring such support staff as needed to participate in a technical software engineering and development discussion.

2. Support the existing and growing users group of ITK (including other contract awards present and future).

3. Develop or modify software for use with ITK exhibiting practical clinical applications of the software or its derivative software engineering tools. Particular emphasis will be placed on clinical relevance, multiscale/multidisciplinary applications, and practical exploration of the uses of ITK. Some example concepts for this work include incorporating ITK with:

    - Algorithms or families of methods not currently represented in ITK
    - haptic visualization and segmentation assistance using ITK
    - A dashboard for 3D tumor evaluation, comparison, and validation (for example, a regression testing system for comparing ITK algorithms against manual tumor evaluations) providing regression testing and comparison of publicly submitted algorithms
    - A segmentation and visualization workstation for diffusion tensor imaging (DTI) MRI data (T1, PD, and DTI echo sequences).
    - Multiscale genome to physiological expression segmentation and visualization with ITK support.
    - Fast interaction techniques for low-latency visualization and segmentation navigation with ITK
    - Inner and middle ear modeling and segmentation including mechanical and electro-physiology simulation
    - Public data storage and deposition libraries and their supporting tools and infrastructure
    - Heart modeling
    - Tools for interpolating development and growth using time-varying data
    - A complete open-source DICOM implementation in ITK (DICOM Store-forward, query-retrieve, etc.)
    - A tumor volume measurement workstation with ITK plug-in capabilities
    - ITK supportable software for creating PACS research archives with automatic scrubbing and de-identification of patient information across PACS vendors.

This is a list of example projects that might be covered under this acquisition. The list is not exhaustive nor does it cover all areas of interest.

OR

Contribute a dataset or data collection to the ITK distribution system that will enhance or improve the ITK offering by supplementing the software with test data for evaluating, validating,

and improving algorithm development. The NLM is placing an emphasis on multiscale, multidisciplinary data (such as sensor data that augments volumetric images) as well as time-varying data from longitudinal studies for clinical trials on chronic degenerative diseases or developmental data associated with neural tract imaging and child development.

4. If providing software not currently in ITK into the Insight Toolkit software base, the successful award winner must also demonstrate the efficacy of the deliverable by contributing a validation test to ITK. This test should measure how well the software performs its designated tasks and demonstrates the software working with multiple computing platforms. Contractors will contribute all test data and testing and validation software to ITK.

   OR

   If contributing datasets or data collections, the successful award winner must take all measures necessary to protect patient privacy and to reformat the data as necessary to comply with the requirements for data distribution under the Visible Human Project.

5. Move the developed code or contributed data to a public repository and assure its placement in the public domain.

6. Contribute documentation, tutorial materials, and courseware.

7. Develop examples of proposed algorithms in ITK or provide renderings of all contributed data.

8. Perform all software and documentation development under the style guidelines and architectural rules of the Insight Toolkit.

Period of Performance

The anticipated period of performance is not to exceed 12 months.

Quality Control

In keeping with the practices for the development of the current Insight Toolkit, all software deliverables will be required to pass through DART, the open-source system for regression testing and quality control. No deliverables will be considered acceptable without checking in the software to the source code repository, and cleared through the dashboard regression testing process. All software, including examples, must be accompanied by software tests, suitable for implementation in the DART dashboard system. All deliverables must pass their own tests as well as not break other tests in the toolkit. Coding style will be checked as a part of the testing process.