United States Department of Commerce
NIST Biomedical Imaging

Today the information content of biomedical imaging, such as in the reading of lung computed tomography (CT), is not fully exploited. By using computer-assistive algorithms in measuring the extent of disease and the response to therapy, physicians could more rapidly identify effective treatments. The Biomedical Imaging Project is researching measures and standards for benchmarking medical imaging algorithms for use in the measurement of disease.

Lead agency:

National Institute of Standards and Technology (NIST)

Agency Mission:

To promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life.

Principal Investigator:

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Partner agency:

NIST ITL is collaborating with other organizations, both inside and outside NIST.

- NIST: The following organizations have contributed assistance with measurements related to the Biomedical Imaging Project: Polymers Division (Contact: Marcus Cicerone); Precision Engineering Division (Contact: Steve Phillips)
- FDA : Center for Devices and Radiological Health (CDRH, Contact: Nicholas Petrick)
- National Cancer Institute including sponsorees: Cancer Imaging Program (CIP, Contact: Laurence Clarke); University of Michigan (Contact: Charles Meyer); Cornell University (Contact: Anthony Reeves)
- Kitware Inc. (Contact: Rick Avila)

General Description:

Excellence: What makes this project exceptional?

Significance: How is this research relevant to older persons, populations, and/or an aging society?

Effectiveness: What is the impact and/or application of this research to older persons?

Innovativeness: Why is this research exciting or newsworthy?

The Biomedical Imaging Project engages with the medical imaging community and with other government scientists at NIST, the FDA, and NCI in a broad-based investigation of the performance of algorithms and computer-assisted diagnostic (CAD) tools for reading biomedical imaging. Medical imaging systems are widely used in the detection and staging of disease, the assessment of response to therapy, and other health-critical applications. Today, expert radiologists provide subjective interpretation, often using computer-assisted diagnostic (CAD) tools. Such measurements depend on the expert, the software tools used, and the conditions of imagery acquisition. The variation, even with computer assistance, can be comparable in magnitude to clinically significant change criteria. The lack of reliable "ground truth" is a fundamental challenge in measuring CAD and algorithm performance. Determining performance metrics is an important area of investigation in the Project.

The Biomedical Imaging Project develops methods for assessing the performance of algorithms and computer-assisted diagnostic (CAD) tools. Currently, we are conducting a multifaceted investigation of the performance of change analysis algorithms applied to computed tomography (CT) imagery of lung lesions. The principal elements of the project are the design and the conduct of benchmarking trials of algorithm performance, with the direct aim of developing reliable algorithm assessment methods and the study, implementation, and application of various change analysis algorithms, in order to better understand and compare their performance. In addition, the availability of a large number of CT scans with known lesion characteristics is essential in conducting benchmarking trials. We are investigating the production of synthetic imagery, intended to eventually provide a robust set of imagery for use in benchmarking evaluations.

This research is significant for aging populations because it applies to the detection, staging, and measurement of clinical response to therapy in cancers. As recently observed, "Cancer in the older person is an increasingly common problem, due to the progressive prolongation of life expectancy..." (Carreca, I; Balducci, L; Extermann, M; Cancer in the older person, *Cancer treatment reviews* [2005]). At the same time, mortality from some cancers, particularly those of the lung, have proven to be stubbornly resistant to modern medical diagnostic and treatment methods.

The research focuses on the use of medical imaging algorithms as part of the development of reliable systems for measuring patient response to therapy. Today, there is rather high uncertainty associated with the assessment of response.

A high reliability measurement of a patient's response to therapy is expected to have impact on improving the determination of malignancy and improving treatment options. The result would improve the clinical practice of cancer therapy. In addition, it promises to shorten

clinical trials used in the development of new pharmaceuticals, by giving the pharmaceutical researcher more rapid indication of effectiveness or lack of response.

Today, the standard method for measuring the extent of disease using imagery, known as RECIST, does not use the full potential of the CT data. We are in the early stages of building a consensus on how to improve the measurement of response to therapy. Measuring the performance of algorithms and CAD tools through benchmarking has proven to be an effective method for improving performance of algorithms in biometrics for detection and identification. Because of our long involvement in such measurements, the medical imaging community is very welcoming of NIST's leadership.