Differential Evolution- Optimization Technique for Noise Reduction

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Abstract

In the emerging global world order, India is trying to position itself as Health and Wellness Center. Health assumes tremendous importance in this context. Large scale changes are being talked about and may indeed be implemented. The challenges are many and momentous, and a successful transition in arena is full of possibilities. Here I present a heuristic approach which works as noise reduction technique in imaging process.

Keywords: Differential Evolution, Inverse Source Problem, Imaging Process.

Introduction

Today, the objects around us are becoming smarter due to the innovations in technology. But, when we see on other hand it creates some harm also. Most of Medical Machines used in Physiological and pathological lab uses rays for imaging. Medical Imaging has led to improvements in the diagnosis and treatment of numerous medical conditions. X-Rays, Gamma Rays radiation damages our tissues and high use of these may Cause of Cancer.

But, today, this started changing slowly as various researchers are now realizing the significance of introducing technology, especially imaging. Very soon, many Hospitals and labs will have using biological imaging as Bioluminescence Tomography.

Bioluminescence tomography (BLT) uses multiple BLI acquisitions, geometrical structures, and tissue optical properties to reconstruct the bioluminescent source distribution based on a photon propagation model.

Medical Imaging

Medical Imaging is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention, as well as visual representation of the function of some organs and tissues (Physiology). Medical imaging has become a major tool in clinical trials since it enables rapid diagnosis with visualization and quantitative assessment. There are many types of medical imaging procedure each of which use different technologies and techniques, CT, Fluoroscopy, Radiography, all uses ionizing radiation to generate images of the body.

Fluoroscopy

Fluoroscopy is an imaging technique that uses X-rays to obtain real-time moving images of the interior of an object. In its primary application of medical imaging, a fluoroscope allows a physician to see the internal structure and function of a patient, so that the pumping action of the heart or the motion of swallowing.

Computed Tomography (CT)

Computed tomography (CT) is an imaging procedure that uses special x-ray equipment to create detailed pictures, or scans, of areas inside the body. CT imaging involves the use of x-rays, which are a form of ionizing radiation. Exposure to ionizing radiation is known to increase the risk of cancer.

Figure1: CT scan

Radiography

Radiography is an imaging technique using X-rays, gamma rays, or similar ionizing radiation and nonionizing radiation to view the internal form of an object. Any given point within the subject is crossed from many directions by many different beams at different times.

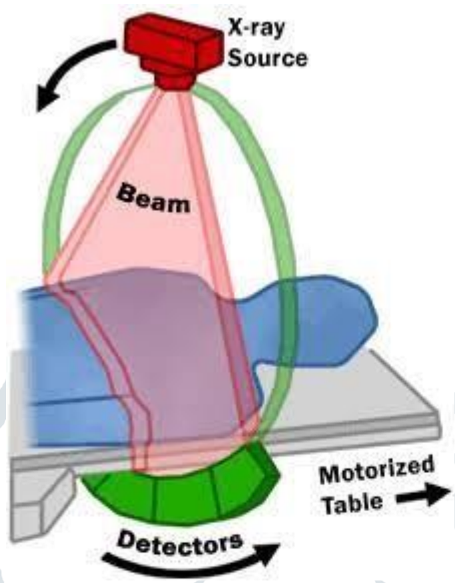

Figure2: X-rays on CT scan

Positron Emission Tomography (PET)

A PET is an imaging test that helps reveal how tissues and organs are functioning as blood flow, oxygen use etc. A PET scan uses a radioactive drug (tracer) to show its activity.

Disadvantage

Ionizing radiation is a form of radiation that has enough energy to damage to DNA and may elevate a person's lifetime risk to developing Cancer.

There are some common disadvantages are as follows:

- Poor soft Tissue contrast
- High Cost
- Low Throughput

- Radioactive material may cause allergic reaction in some people
- *Inverse Source Problem*
- Limited Spatial Resolution

Bioluminescence tomography (BLT) is an emerging optical imaging mode with promising biomedical advantages. Bioluminescence tomography (BLT) uses multiple BLI acquisitions, geometrical structures, and tissue optical properties to reconstruct the bioluminescent source distribution based on a photon propagation model.

Bioluminescence imaging (BLI) is a molecular imaging modality, which can be used to monitor physiological and pathological activities at the molecular level. Various applications include visualizing tumor growth, tracking tumor cell metastasis, and evaluating drug delivery.

Bioluminescence tomography (BLT) is an inverse source problem that localizes and quantifies bioluminescent probe distribution in 3-D. The generic BLT model is ill-posed, leading to non-unique solutions and aberrant reconstruction in the presence of measurement noise and optical parameter mismatches.

Inverse Source Problem

The process of calculating from a set of observations the causal factors that generated them is called Inverse Source Problem; for example calculating an image in X-ray computed tomography, source reconstruction.

Ill posed

Problems which are not well posed in the sense of Hadamard are termed ill posed. For example the inverse heat equation, deducing a previous distribution of temperature from final data, is ill posed in that the solution is highly sensitive to changes in the final data.

Differential Evolution

Differential Evolution is a simple and efficient heuristic for global optimization. Differential Evolution is proposed by Price and Storn. Differential Evolution is a technique that optimizes a problem by trying again and again to improve candidate solution with regard to given measure of quality.

Differential Evolution optimizes by maintaining a population having candidate solution and generating new candidate solution by using its formulae.

$$U = Xr_0 + F \cdot (Xr_1 - Xr_2)$$

where

U is the generated trial vector;

r_0 is the index of the base vector;

r_1 and r_2 are the indices of the difference vectors;

F is the difference scaling factor.

Trial vector my replace with target vector with index i.

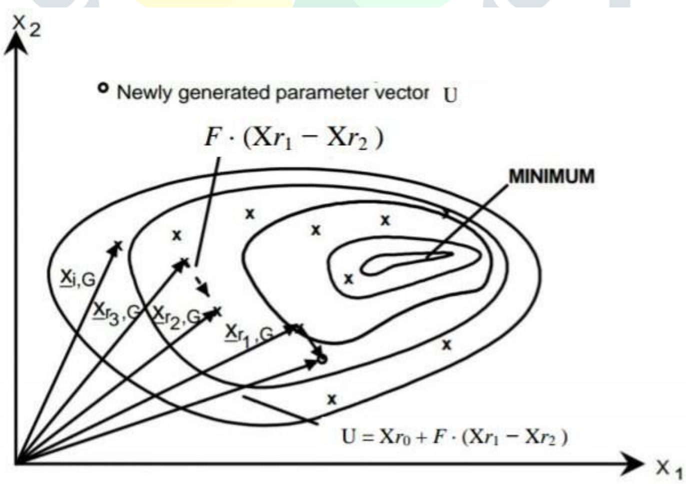

Figure 3: An example of a two-dimensional cost function showing its contour lines and the process for generating U

Algorithm

- Set the number of bioluminescence source S <= 0.
- Initialize all candidate solution X with random position in the search space
- Repeat until termination criteria is not met
    - Randomly pick three solution Xr_0, Xr_1, $X r_2$
    - $U = Xr_0 + F \cdot (Xr_1 - Xr_2)$
    - Crossover
    - Evaluate U
    - If U<X
    - Replace
- $X^{opt} <= \min X_i$

New Technology with Differential Evolution Algorithm

The differential evolution algorithm is applied to solve inverse source problem by integrating the number of bioluminescent sources as constraint in its encoding scheme and locating the global optimum solution using a metaheuristic approach. This novel method greatly enhances the accuracy and stability of the reconstruction.

Experimental Study

The experiments performed on an ellipsoidal digital phantom with a total length of 30mm and maximum width of 14mm; the geometrical center was located at the origin of Cartesian coordinates.

Not much difference between first and second can see simply and cannot be confidently estimate the number of sources. WE applied the proposed method to recover the number of source, source location.

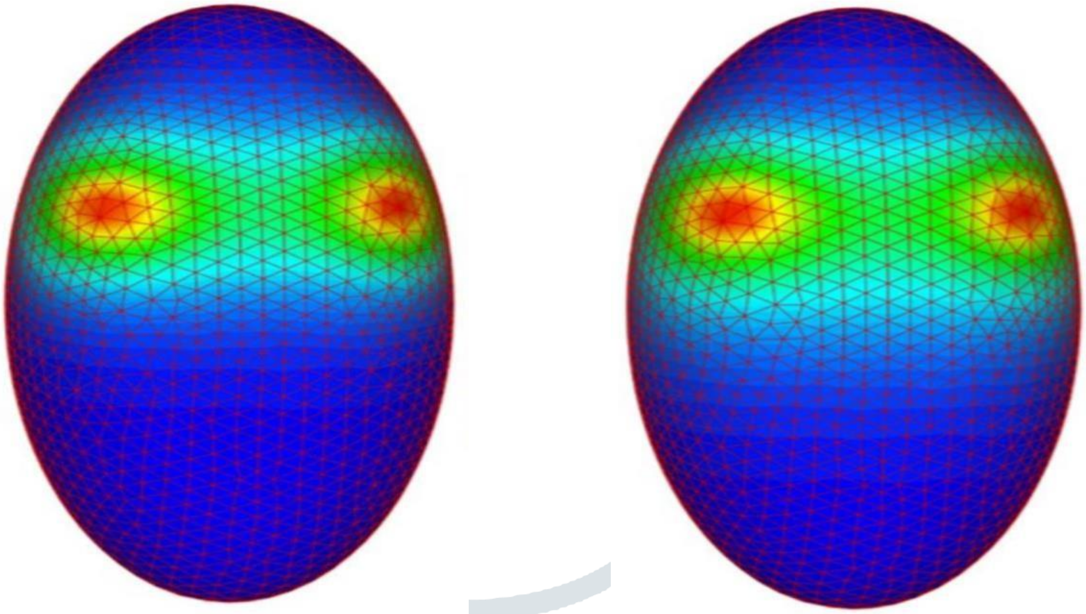

Figure 4: Simulated boundary photon fluence rate. (a) Boundary photon fluence rate from two point sources. (b) Boundary photon fluence rate from three point sources

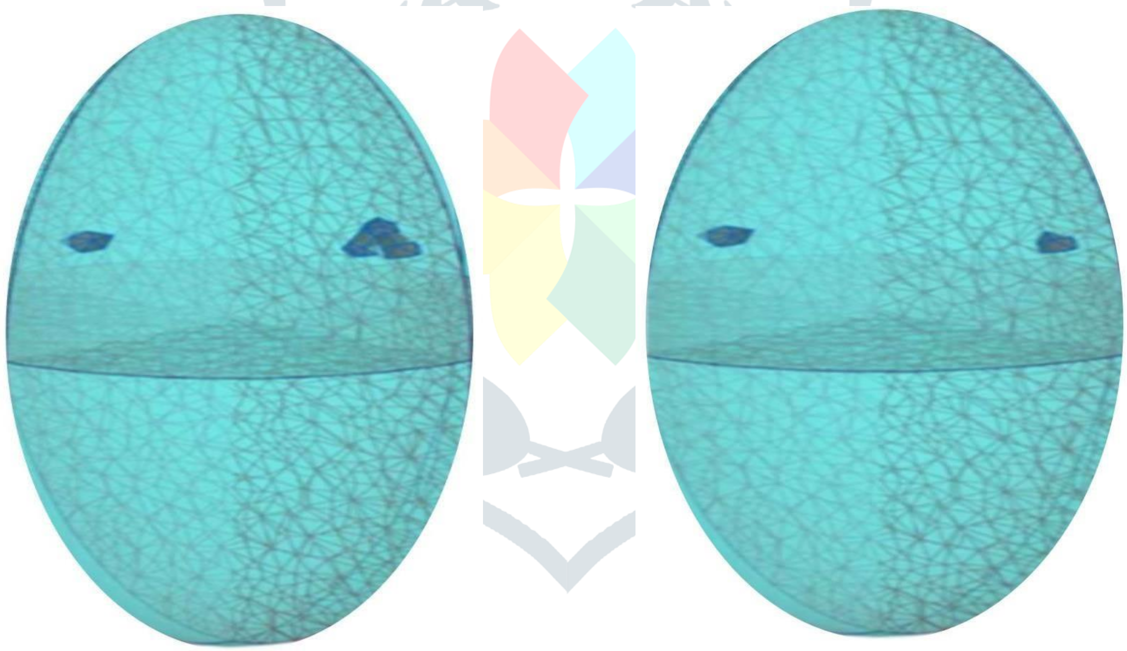

Figure5: Reconstruction Result of (a) and (b) respectively

In the first set of experiments, the effectiveness of the number of sources determination method and the accuracy of the reconstruction.

Conclusion

In this research paper, we present Bioluminescence tomography over computed Tomography or radiography with Differential Evolution. Bioluminescence tomography removes some disadvantage like high cost, ionizing radiation, Low throughput etc. **Differential Evolution** reduces other remaining disadvantage as, noisy 3D representation, Limited Resolution. So these are helpful research work for Future researcher and Medical Labs.

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