UNIVERSITI TEKNOLOGI MARA

HYBRID CONJUGATE GRADIENT METHOD UNDER EXACT LINE SEARCH FOR AN OPTICAL COHERENCE TOMOGRAPHY INVERSE PROBLEM

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ABSTRACT

Conjugate Gradient (CG) methods are mathematical techniques used to solve large optimization problems. It was widely used in numerical optimization due to their low memory requirements and strong convergence properties which making them particularly suitable for large-scale problems. However, classical CG methods such as Fletcher-Reeves (FR), Polak-Ribière-Polyak (PRP) and others each have inherent strengths and weaknesses in terms of convergence speed, global convergence guarantees and numerical stability. To overcome the limitations of classical CG methods, the researcher has developed several hybrid CG methods aimed to improving the efficiency and convergence performance of the CG methods. Therefore, this study investigates several hybrid CG coefficients by combining Polak-Ribiere-Polyak (PRP) method with classical and modified CG coefficient which is Conjugate Descent (CD), Fletcher-Reeves (FR), Linda-Aini-Mustafa-Rivaie (LAMR) and Srimazzura-Mustafa-2 (SM-2) and denoted as PRPCD, PRPFR, PRPLAMR, and PRPSM-2 respectively. Each hybrid method was tested under exact line search on fifteen benchmark functions drawn from the CUTE library, using multiple initial points and problem dimensions ranging from 2 to 10,000 variables. Performance was assessed using performance profiles based on the number of iterations (NOI) and CPU time. All four coefficients successfully solved every test problem, achieving a 100% success rate. However, performance profile analysis identified PRPLAMR as the most efficient and robust method because it requiring the fewest iterations and lowest CPU time on the majority of problems, Then, best-performing hybrid method which is PRPLAMR is applied to a real-world case which is Optical Coherence Tomography (OCT) inverse problem which is formulated as a large-scale least-squares optimization problem with no noise and noise which are 0.1, 0.5 and 0.75 noise levels. PRPLAMR is successfully reconstruct the image especially under low-noise conditions. This shows its potential for solving large, nonlinear inverse problems in medical imaging applications.