ASU School of Mathematical and Statistical Sciences
Arizona State University

M E M O R A N D U M

DATE: 03/22/2024

TO: Faculty and Students

FROM: Professor(s)   Malena Espanol
            Chair/Co-Chairs of   Bechir Amdouni
            Defense for the   PhD   in   Applied Mathematics
            Committee Members
                                        John Fricks
                                        Mohamed Moustaoui
                                        Rodrigo Platte
                                        Rosemary Renaut

DEFENSE ANNOUNCEMENT

Candidate: Bechir Amdouni

Defense Date: Thursday, April 11, 2024

Defense Time: 2:00 PM

Virtual Meeting Link: https://asu.zoom.us/j/83926249289
In Person: WXLR Wexler Hall (Tempe) Room 206

Title: Wavelet-Based Multilevel Krylov Methods For Solving The Image Deblurring Problem

Please share this information with colleagues and other students, especially those studying in similar fields. Faculty and students are encouraged to attend. The defending candidate will give a 40-minute talk, after which the committee members will ask questions. There may be time for questions from those in attendance. However, guests are invited to attend as observers and will be excused when the committee begins its deliberations or if the committee wishes to question the candidate privately.

ABSTRACT
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ABSTRACT

In the realm of discrete ill-posed problems, image deblurring is a challenging problem aimed at restoring clear and visually appealing images from their blurred counterparts. Over the years, various numerical techniques have been developed to solve this problem, each offering unique approaches to tackle blurring and noise. This thesis studies multi-level methods using Daubechies wavelets and Tikhonov regularization. The Daubechies wavelets are a family of orthogonal wavelets widely used in various fields because of their orthogonality and compact support. They have been widely applied in signal processing, image compression, and other applications. One key aspect of this investigation involves a comprehensive comparative analysis with Krylov methods, well-established iterative methods known for their efficiency and accuracy in solving large-scale inverse problems. The focus is on two well-known Krylov methods, namely LSQR and generalized minimal residual method (GMRES). By contrasting the multilevel and Krylov methods, the aim is to discern their strengths and limitations, facilitating a deeper understanding of their applicability in diverse image-deblurring scenarios. Other critical comparison factors are the noise level adopted during the deblurring process and the amount of blur. To gauge their robustness and performance under different blurry and noisy conditions, this work explores how each method behaves with different noise levels from mild to severe and different amounts of blur from small to large. Moreover, this thesis combines multilevel and Krylov methods to test a new method for solving inverse problems. This work aims to provide valuable insights into the strengths and weaknesses of these multilevel Krylov methods by shedding light on their efficacy. Ultimately, the findings could have implications across diverse domains, including medical imaging, remote sensing, and multimedia applications, where high-quality and noise-free images are indispensable for accurate analysis and interpretation.