Accepted Manuscript

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PII: S0893-9659(17)30364-6
DOI: https://doi.org/10.1016/j.aml.2017.12.003
Reference: AML 5389

To appear in: *Applied Mathematics Letters*

Received date : 19 November 2017
Revised date : 3 December 2017
Accepted date : 3 December 2017

Please cite this article as: D. Zhang, F. Sun, L. Lu, Y. Guo, A harmonic polynomial method with a regularization strategy for the boundary value problems of Laplace's equation, Appl. Math. Lett. (2017), https://doi.org/10.1016/j.aml.2017.12.003

A harmonic polynomial method with a regularization strategy for the boundary value problems of Laplace's equation

Deyue Zhang[a], Fenglin Sun[a], Linyan Lu[a], Yukun Guo[b,*]

[a] *College of Mathematics, Jilin University, Changchun, P. R. China*
[b] *Department of Mathematics, Harbin Institute of Technology, Harbin, P. R. China*

Abstract

This paper concerns a boundary value problem of Laplace's equation, which is solved by determining the unknown coefficients in the expansion of harmonic polynomials. A regularization method is proposed to tackle the resulting ill-posed linear system. The stability and convergence results are provided and a validating numerical experiment is presented.

Keywords: harmonic polynomial, regularization, Laplace's equation
2000 MSC: 35N25, 35R25, 65N12

1. Introduction

This paper is concerned with the boundary value problems (BVP) of Laplace's equation, and a harmonic polynomial method (HPM) is considered to solve the problems. The HPM was the first to be presented in [3] to solve the Cauchy problems for the Laplace equation. Motivated by [3], the main idea of solving the BVP is to approximate the exact solution by a linear combination of the harmonic polynomials. Then the problems are approximated by determining the unknown coefficients in the linear combination. By using the boundary conditions, a compact operator equation is obtained and solved by a regularization method. In this paper, we propose an approach to derive a lower bound for the smallest singular value of the

*Corresponding author.
Email address: ykguo@hit.edu.cn (Yukun Guo)