A collocation Trefftz method with a post-conditioner for solving 2D Helmholtz problems in arbitrary domains with high wave numbers

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In this study, a collocation Trefftz method is proposed to form a boundary type meshless method for solving the Helmholtz problems in arbitrary plane domains. The solution is expressed by a linear combination of the T-complete functions and higher order terms are needed for higher wave number problem. The resultant linear systems obtained by the conventional collocation Trefftz method are ill-posed due to the oscillations of the higher order terms even for solving direct problems, and it is difficult to compute the strength of the bases accurately. To overcome this deficiency we propose a new method to reduce the condition number of the resultant matrix by using a novel post-conditioner, which is obtained by the multiple length scales collocation Trefftz method for solving the Laplace equation. Several numerical examples are provided to demonstrate the ability that the post-conditioner can reduce the condition number effectively. The present results are accurate and stable since the ill-posed systems are transformed into well-posed ones successfully by the presently proposed post-conditioner.

Keywords: Collocation Trefftz method, post-conditioner, Helmholtz problems, high wave number.