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THE INEFFICIENCY OF STANDARD MULTIGRID METHODS FOR SADDLE-POINT PROBLEMS WITH INDEFINITE (1,1) BLOCK
Type 2. Presentation of things that did not work (as expected)

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Saddle-point problems of the form

$$\begin{bmatrix} \mathcal{A} & \mathcal{C} \\ \mathcal{B} & \mathbf{0} \end{bmatrix} \begin{bmatrix} \mathbf{x} \\ \mathbf{p} \end{bmatrix} = \begin{bmatrix} f \\ g \end{bmatrix}.$$

with an indefinite $\mathcal{A}$ block (related to the momentum balance equation) arise in various area of computational science, such as incompressible fluid dynamics, incompressible mechanics and time-harmonic wave propagation problems[1]. Unexpectedly, standard multigrid methods perform very poorly in case we consider a saddle-point problem. This issue is worsened if the $\mathcal{A}$ block is indefinite. We evaluated the performances of the semigeometric multigrid method in this latter case. In detail, we investigated their performances for the solution of problems in incompressible mechanics. Moreover, we demonstrated that strategies to improve the performances of multigrid methods exist. Transforming the initial problem in an equivalent one we discuss the applicability of multigrid methods for problems with an indefinite $\mathcal{A}$ block. We underlined how the idea could be applied to numerous algorithms which are effective for problems with a positive definite or semipositive definite block $(1, 1)$.

REFERENCES

[1] M. Benzi, J. Liu *Block preconditioning for saddle point systems with indefinite (1,1) block.* 2007. *International Journal of Computer Mathematics.*