

MATRIX INEQUALITIES INCLUDING GRAND FURUTA INEQUALITY VIA KARCHER MEAN

MASATOSHI ITO

Abstract. In our previous paper, we have shown a generalization of Furuta inequality via Karcher mean (Riemannian mean) by using Yamazaki's results which are generalizations of Ando-Hiai inequality and related ones. In this paper, we shall show a generalization of grand Furuta inequality as an extension of our previous result.

Mathematics subject classification (2010): Primary 15A45, 47A63. Secondary 15B48, 47A64.

Keywords and phrases: Positive definite matrix, Karcher mean, Furuta inequality and grand Furuta inequality.

REFERENCES

- [1] T. ANDO AND F. HIAI, *Log majorization and complementary Golden-Thompson type inequalities*, Linear Algebra Appl., **197**, **198** (1994), 113–131.
- [2] T. ANDO, C. K. LI AND R. MATHIAS, *Geometric means*, Linear Algebra Appl., **385** (2004), 305–334.
- [3] R. BHATIA, *Positive definite matrices*, Princeton Series in Applied Mathematics, Princeton University Press, Princeton, NJ, 2007.
- [4] R. BHATIA AND J. HOLBROOK, *Riemannian geometry and matrix geometric means*, Linear Algebra Appl., **413** (2006), 594–618.
- [5] D. A. BINI, B. MEINI AND F. POLONI, *An effective matrix geometric mean satisfying the Ando-Li-Mathias properties*, Math. Comp., **79** (2010), 437–452.
- [6] M. FUJII, *Furuta's inequality and its mean theoretic approach*, J. Operator Theory, **23** (1990), 67–72.
- [7] M. FUJII, T. FURUTA AND E. KAMEI, *Furuta's inequality and its application to Ando's theorem*, Linear Algebra Appl., **179** (1993), 161–169.
- [8] M. FUJII AND E. KAMEI, *Mean theoretic approach to the grand Furuta inequality*, Proc. Amer. Math. Soc., **124** (1996), 2751–2756.
- [9] T. FURUTA, *$A \geq B \geq 0$ assures $(B^r A^p B^r)^{1/q} \geq B^{(p+2r)/q}$ for $r \geq 0$, $p \geq 0$, $q \geq 1$ with $(1+2r)q \geq p+2r$* , Proc. Amer. Math. Soc., **101** (1987), 85–88.
- [10] T. FURUTA, *An elementary proof of an order preserving inequality*, Proc. Japan Acad. Ser. A Math. Sci., **65** (1989), 126.
- [11] T. FURUTA, *Applications of order preserving operator inequalities*, Oper. Theory Adv. Appl., **59** (1992), 180–190.
- [12] T. FURUTA, *Extension of the Furuta inequality and Ando-Hiai log-majorization*, Linear Algebra Appl., **219** (1995), 139–155.
- [13] T. FURUTA, *Simplified proof of an order preserving operator inequality*, Proc. Japan Acad. Ser. A Math. Sci., **74** (1998), 114.
- [14] M. ITO, *Matrix inequalities including Furuta inequality via Riemannian mean of n -matrices*, J. Math. Inequal., **6** (2012), 481–491.
- [15] S. IZUMINO AND N. NAKAMURA, *Weighted geometric means of positive operators*, Kyungpook Math. J., **50** (2010), 213–228.
- [16] E. KAMEI, *A satellite to Furuta's inequality*, Math. Japon., **33** (1988), 883–886.
- [17] J. D. LAWSON AND Y. LIM, *Monotonic properties of the least squares mean*, Math. Ann., **351** (2011), 267–279.

- [18] M. MOAKHER, *A differential geometric approach to the geometric mean of symmetric positive-definite matrices*, SIAM J. Matrix Anal. Appl., **26** (2005), 735–747.
- [19] K. TANAHASHI, *Best possibility of the Furuta inequality*, Proc. Amer. Math. Soc., **124** (1996), 141–146.
- [20] K. TANAHASHI, *The best possibility of the grand Furuta inequality*, Proc. Amer. Math. Soc., **128** (2000), 511–519.
- [21] T. YAMAZAKI, *The Riemannian mean and matrix inequalities related to the Ando-Hiai inequality and chaotic order*, Oper. Matrices., **6** (2012), 577–588.