

Robust and Optimal Sensor Fusion

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Abstract—Abstract text to be done

Index Terms—Complementary Filters, Sensor Fusion, H_{infinity} Synthesis

I. INTRODUCTION

II. OPTIMAL SUPER SENSOR NOISE: H₂ SYNTHESIS

A. Sensor Fusion Architecture

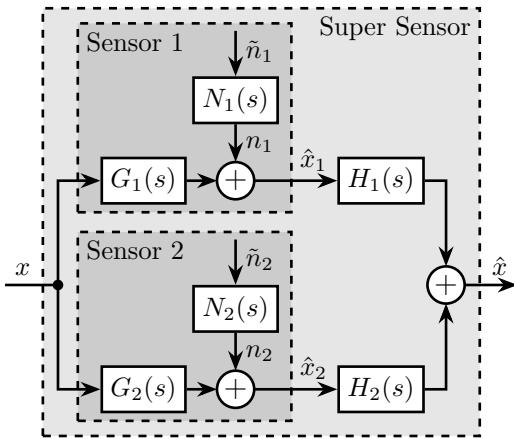


Fig. 1. Figure caption

B. Super Sensor Noise

C. H₂ Synthesis of Complementary Filters

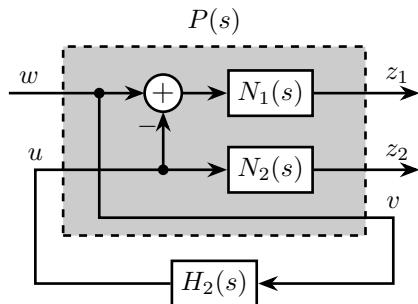


Fig. 2. Figure caption

D. Example

E. Robustness Problem

III. ROBUST SENSOR FUSION: H_{infinity} SYNTHESIS

A. Representation of Sensor Dynamical Uncertainty

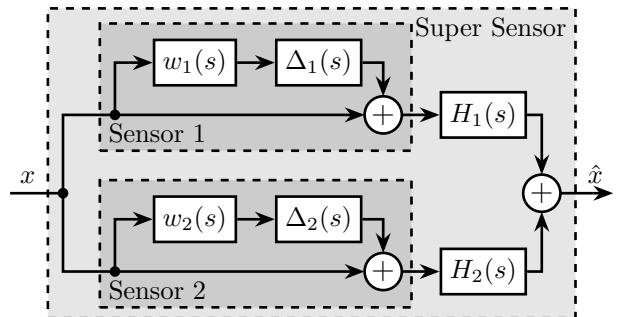


Fig. 3. Figure caption

B. Super Sensor Dynamical Uncertainty

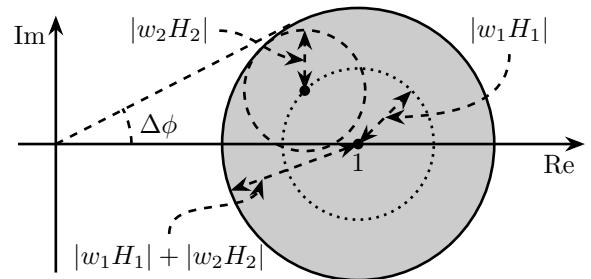


Fig. 4. Figure caption

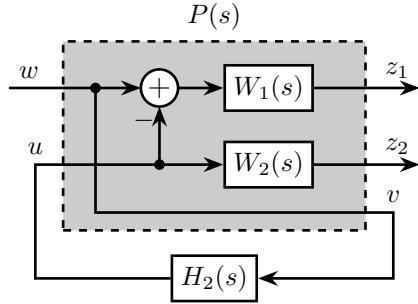


Fig. 5. Figure caption

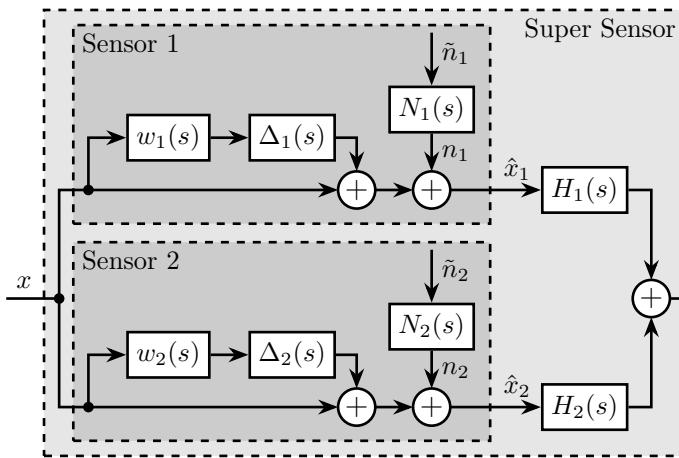


Fig. 6. Figure caption

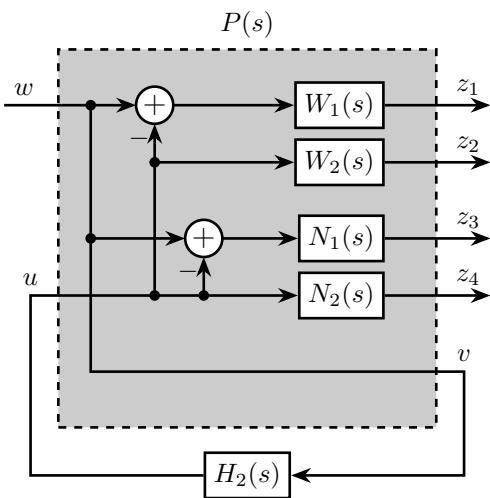


Fig. 7. Figure caption

C. \mathcal{H}_∞ Synthesis of Complementary Filters

D. Example

IV. OPTIMAL AND ROBUST SENSOR FUSION: MIXED $\mathcal{H}_2/\mathcal{H}_\infty$ SYNTHESIS

A. Sensor Fusion Architecture

B. Synthesis Objective

C. Mixed $\mathcal{H}_2/\mathcal{H}_\infty$ Synthesis

D. Example

V. EXPERIMENTAL VALIDATION

A. Experimental Setup

B. Sensor Noise and Dynamical Uncertainty

C. Mixed $\mathcal{H}_2/\mathcal{H}_\infty$ Synthesis

D. Super Sensor Noise and Dynamical Uncertainty

VI. CONCLUSION

VII. ACKNOWLEDGMENT

REFERENCES

- [1] M. Zimmermann and W. Sulzer, "High bandwidth orientation measurement and control based on complementary filtering," *Robot Control 1991*, pp. 525–530, 1992. [Online]. Available: <https://doi.org/10.1016/b978-0-08-041276-4.50093-5>
- [2] P. Corke, "An inertial and visual sensing system for a small autonomous helicopter," *Journal of Robotic Systems*, vol. 21, no. 2, pp. 43–51, 2004. [Online]. Available: <https://doi.org/10.1002/rob.10127>
- [3] H. G. Min and E. T. Jeung, "Complementary filter design for angle estimation using mems accelerometer and gyroscope," *Department of Control and Instrumentation, Changwon National University, Changwon, Korea*, pp. 641–773, 2015.
- [4] F. Shaw and K. Srinivasan, "Bandwidth enhancement of position measurements using measured acceleration," *Mechanical Systems and Signal Processing*, vol. 4, no. 1, pp. 23–38, 1990. [Online]. Available: [https://doi.org/10.1016/0888-3270\(90\)90038-m](https://doi.org/10.1016/0888-3270(90)90038-m)
- [5] F. Matichard, B. Lantz, R. Mittleman, K. Mason, J. Kissel, B. Abbott, S. Biscans, J. McIver, R. Abbott, S. Abbott *et al.*, "Seismic isolation of advanced ligo: Review of strategy, instrumentation and performance," *Classical and Quantum Gravity*, vol. 32, no. 18, p. 185003, 2015.
- [6] W. Hua, D. B. Debra, C. T. Hardham, B. T. Lantz, and J. A. Giamei, "Polyphase fir complementary filters for control systems," in *Proceedings of ASPE Spring Topical Meeting on Control of Precision Systems*, 2004, pp. 109–114.
- [7] C. Collette and F. Matichard, "Sensor fusion methods for high performance active vibration isolation systems," *Journal of Sound and Vibration*, vol. 342, no. nil, pp. 1–21, 2015. [Online]. Available: <https://doi.org/10.1016/j.jsv.2015.01.006>
- [8] A. Jensen, C. Coopmans, and Y. Chen, "Basics and guidelines of complementary filters for small uas navigation," in *2013 International Conference on Unmanned Aircraft Systems (ICUAS)*, 5 2013, p. nil. [Online]. Available: <https://doi.org/10.1109/icuas.2013.6564726>
- [9] W. Hua, "Low frequency vibration isolation and alignment system for advanced ligo," Ph.D. dissertation, stanford university, 2005.
- [10] R. Mahony, T. Hamel, and J.-M. Pfliimlin, "Nonlinear complementary filters on the special orthogonal group," *IEEE Transactions on Automatic Control*, vol. 53, no. 5, pp. 1203–1218, 2008. [Online]. Available: <https://doi.org/10.1109/tac.2008.923738>
- [11] A. Pascoal, I. Kaminer, and P. Oliveira, "Navigation system design using time-varying complementary filters," in *Guidance, Navigation, and Control Conference and Exhibit*, 1999, p. nil. [Online]. Available: <https://doi.org/10.2514/6.1999-4290>
- [12] R. G. Brown, "Integrated navigation systems and kalman filtering: a perspective," *Navigation*, vol. 19, no. 4, pp. 355–362, 1972. [Online]. Available: <https://doi.org/10.1002/j.2161-4296.1972.tb01706.x>