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A New Approach to Design of Nonlinear Observers Robust to Measurement Disturbances, with Applications to Quantized Feedback Control

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Proposal Summary

The overall goal of the proposed research is to enable control design for general nonlinear dynamical systems whose output measurements are corrupted by additive disturbances. In applications, the presence of such disturbances can be due to the following reasons, among others:

- Network scheduling protocols and time delays in control over networks
- Quantization due to limited bandwidth and vision-based sensing
- Restricted sensor capabilities in embedded or distributed sensing scenarios
- Judicious information transmission due to security considerations

Since a central step in control synthesis is the design of a state observer, in such scenarios the observer needs to be robust with respect to additive disturbances. Existing observer designs typically do not provide this type of robustness. The main goals of the proposed research are to develop a framework for robust observer design, consisting of:

- A precise formulation of the desired observer robustness property
- A methodology for designing observers that possess this property for wide classes of systems
- An integration of this observer design into the overall feedback control design, illustrated on practical problems such as quantized feedback.

To answer the proposed questions, the strategy of this research is to:

1. Introduce a new notion: ‘quasi-input-to-state-stable (quasi-ISS) observer’
2. Develop a general and versatile framework for quasi-ISS observer design, which provides guidelines for designing nonlinear injection gains
3. Identify concrete classes of systems – as many as possible – to which our design method applies in a constructive manner
4. Develop an output-feedback scheme that incorporates quantized measurements and/or vision-based measurement delays and errors