Nonlinear Observers with Linear Error Dynamics

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Abstract: It is my pleasure to participate in this workshop honoring the outstanding scientific career of Witold Respondek. Vitek is the "Great Linearizer". With Jacubcyk he was the first to give necessary and sufficient conditions for existence of a nonlinear change of state coordinates and a nonlinear state feedback that transforms a nonlinear controlled dynamics into a linear controlled dynamics. With Krener he gave necessary and sufficient conditions for existence of nonlinear change of state coordinates, a nonlinear change of output coordinates and a nonlinear input-output injection that transforms a nonlinear controlled and observed dynamics into a form which admits an observer with linear, exponentialy stable error dynamics in the transformed variables. This work inspired a large number of susequent studies that we will discuss. Perhaps the most interesting is the work of Kazantzis and Kravaris. For nonlinear observed (but uncontrolled) dynamics they showed how to construct an observer with linear, exponentialy stable error dynamics in the transformed variables. Such observers are now known as KKL observers. Krener and Xiao showed that any observer with linear, exponentialy stable error dynamics in transformed variables is an extension of a KKL observer. This extension of a KKL observer by Krener and Xiao introduces free parameters which can be tuned by machine learning. Kreisselmeier and Engel introduced a different extension of a KKL observer with linear error dynamics and their observers have more free parameters which might also be tuned by machine learning.