Some Important Notions in Regional Asymptotic Distributed Parameter Systems Analysis

By

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Now before we present our work with Prof EL-JAI, there must give an introduction to the distributed parameter systems (DPS_s) analysis and explain the relation with our research. As well known in numerous papers, that (DPS_s) can be made abstractly by considering various functional spaces and operators to introduce some definitions and establish some characterizations and properties. Generally the space variable is fairly exploited. Thus, it was possible to study the link of various concepts in systems analysis with the structure and spatial location of the sensors and actuators. Therefore, we can establish relations between observability (detectability and observer Luenberger) and sensors on the one hand and between the controllability (stabilizability) and actuators on the other hand. Among the most important concepts in asymptotic analysis of distributed parameter systems are those of detectability, construction observer or the stabilizability have been achieved in many studies by El Jai *et al.*, [in several papers 1978]. All results cited above have been developed on whole domain Ω of considered geometric system. Furthermore, the study of the observability and controllability of specific regions of the considered geometric area is relatively recent. The problem was introduced and developed by El Jai, Pritchard and Zerrik (1990). This is, a new direction in distributed systems has been explored whether an unobservable (or uncontrollable) system on the global domain Ω may be observable (or controllable) on a region $\omega \subset \Omega$. This study can be called regional systems analysis and is more suitable for (DPS_s). The extension of these concepts to regional case on a part of the boundary of Ω has been developed by El Jai and Zerrik [1993]. Another orientation is the regional gradient analysis recently introduced by El Jai and Zerrik *et al.*, [2000]. Most results in the regional analysis are performed on a finite time horizon.

The purpose of our work is the possibility to extend these results to the case of an infinite time horizon (regional asymptotic analysis 1997- ?).
More precisely Al-Saphory and El-Jai introduce, explore, proposed, develop study and analyze some of asymptotic notions in various

articles as stated and detailed in the following impact factor journals and international conferences in which, I participated with El Jai or under his supervision:

[1] R. Al-Saphory, A. El Jai, Observateur de type Luenberger régional, Journée thématique Modélisation et Contrôle, Université de Perpignan, France, 30 mars, 1999.
This is the first conference with Prof. El Jai which concerns with the characterization of Luenberger observer type in infinite dimensional systems of general case in sub region of the considered system domain.

[2] R. Al-Saphory, A. El Jai, Regional Luenberger observer and sensors structures, rapport N.2 /2001, Laboratoire Théorie des systèmes, Université de Perpignan, France, pp. 1-20, 2001.
In this article, we have studied and analysed the relations between the sensors structures and regional Luenberger observer of general case and we show under which condition can be characterized.

[3] R. Al-Saphory, A. El Jai, Sensors structures and regional detectability of parabolic distributed systems, International Journal on Sensors and Actuators A, Vol. 90, No. 3, pp.163-171, 2001.
In this paper, we deal with linear infinite dimensional in a Hilbert space where the dynamic of the system is governed by strongly continuous semi group, We studied the concept of regional detectability in connection with the structures of sensors for parabolic (DPS_S). For different sensors, we give the characterization of the asymptotic regional detectability in order the asymptotic observability to be achieved.

[4] R. Al-Saphory, , A. El Jai, Sensors structures and regional exponential detectability, European Control Conference, ECC 2001, 4-7 September, Porto, Portugal, 2001.
This conference was devoted the study of the concept of regional exponential detectability in connection with the structures of sensors for parabolic (DPS_S). Furthermore, we applied these results to a regional observer for diffusion systems.

[5] R. Al-Saphory, A. El Jai, Sensors and asymptotic ω-observer for distributed diffusion systems, International Journal of Sensors, Vol. 1, pp. 161-182, 2001.
The aim of this paper was to study the regional observer concept through the consideration of sensors. For a class of distributed diffusion systems, we proposed an approach derived from the Luenberger observer type as introduced by Gressang and Lamont. Furthermore, we showed that,

there exists a dynamical system for diffusion systems which was not observer in the usual sense, but it might be regional observer.

[6] R. Al-Saphory, A. El Jai, Sensors characterizations for regional boundary detectability of distributed parameter systems, International Journal on Sensors and Actuators A, Vol. 94, No. 1, pp. 1-10, 2001.
The purposed of this paper was to explore the concept of regional boundary detectability in connection with the characterization of sensors. We also presented some original results concerning diffusion systems which allow the possibility to construct a regional boundary observer.

[7] R. Al-Saphory, A. El Jai, Asymptotic regional state reconstruction, International Journal of Systems Science, Vol. 33, pp. 1025-1037, 2002.
The aim of this article was to explore the concept of regional asymptotic observation for a class of parabolic (DPS_S). We showed the links with regional detectability and strategic sensors. We also showed that there is a dynamical system that is not observer in the usual sense, but that might be regional observer. Furthermore, we considered the use of regional observers in regional closed-loop control systems.

[8] R. Al-Saphory, Analyse régionale asymptotique d'une classe de systèmes distribués. Vol. 2011; Edition: 1, Publisher: Amazon, Editor: Google Books, ISBN: HAL, CNRS, tel-00001481, version 1. 2012.
This work concerned the introduction of some notions (detectability, stabilizability, and observer) in asymptotic regional analysis for a class of distributed parameter systems. Different properties and characterizations were established, in particular in connection with sensors and actuators structure.

[9] R. Al-Saphory, A. El Jai, M. Jasim, Characterizations of measurements and controls for asymptotic regional state reconstruction, Journal of Measurement, accepted 2014.
The purpose of this paper was to study the concept of asymptotic regional observer in connection with the characterizations of sensors and actuators. It has been shown that the structures of measurements controls allow the existence of regional observer with sufficient condition for such observer.
The important of these researches are motivated by many real problems including thermal problem, green house (high performance buildings), MAS-Net ... and our model in various international applications as in the following references was used:

[1] Y. Chen.; K., Moore, Z., Song, Diffusion boundary determination and zone control via, mobile actuators-sensors networks (MAS-net)-challenge and opportunities, *SCOIS, Utah state university, Logan, UT84322, USA,* **2004.**

[2] J., Burns; J., Jorggaard,.; M.., Cliff, L., Zietsman , A PDE approach to *Numerical Techniques for Optimization Problems with PDE Constraints, No. 04/2009, DOI: 10.4171/OWR/2009/04,* 25-31 January, Houston, Denmark, **2009.**

[3] J., Burns; C., Rautenberg, M., Cliff, L., Zietsman, Optimal sensors design for optimization of PDE system, 2010 American Control Conference Marriott Waterfront, Baltimore, MD, USA, June 30-july 02, **2010.**

Finally, I must praise to Allah, the cherisher and sustainer of these works. In the occasion of retirement of prof EL Jai, I would like to express my deep gratitude to him for having introduced and proposed the subject of my research domain and for his valuable suggestions, extensive discussions, and continuous guidance and consultations from 1997- ?.

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