



**HAL**  
open science

## Guaranteed state estimation by zonotopes for systems with interval uncertainties

Vu Tuan Hieu Le, Cristina Stoica, T. Alamo, E.F. Camacho, Didier Dumur

► **To cite this version:**

Vu Tuan Hieu Le, Cristina Stoica, T. Alamo, E.F. Camacho, Didier Dumur. Guaranteed state estimation by zonotopes for systems with interval uncertainties. SWIM 2012, Jun 2012, Oldenburg, Germany. pp.CD-Rom. hal-00708563

**HAL Id: hal-00708563**

**<https://centralesupelec.hal.science/hal-00708563>**

Submitted on 16 Mar 2020

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Guaranteed state estimation by zonotopes for systems with interval uncertainties

V.T.H. Le\*      C. Stoica\*      T. Alamo<sup>†</sup>  
E.F. Camacho<sup>†</sup>      D. Dumur\*

This talk focuses on guaranteed state estimation by zonotopes [1], [2] applied to multivariable linear discrete-time systems in the presence of disturbances, noises and interval uncertainties. Suppose that the perturbations and the noise are unknown but bounded by some zonotopic sets. Under this hypothesis the information about the system states at each sample time is characterized as a zonotope containing all possible system states that are consistent with the considered perturbations and measurement noise.

In [2] a zonotopic outer approximation of the state estimation domain is computed based on the minimization of the  $P$ -radius associated to the zonotope. The main idea consists in an outer approximation of the intersection of a zonotope (corresponding to the prediction of the states) with a strip (the measurement from the available sensor). Despite the good approximation, this approach is applied in [2] only to Single-Input Single-Output systems that are not affected by uncertainties. In order to extend this approach to multivariable systems with interval uncertainties, this talk proposes a zonotopic approximation of the intersection between a zonotope (the prediction of the states) and a polytope (the intersection of the measurements from all the sensors). The size of this zonotope is decreased in time by solving an off-line optimization problem. The advantages of this approach are illustrated via a numerical example.

## References

- [1] T. Alamo, J.M. Bravo, and E.F. Camacho. Guaranteed state estimation by zonotopes. *Automatica*, 41:1035–1043, 2005.
- [2] V.T.H. Le, T. Alamo, E.F. Camacho, C. Stoica, and D. Dumur. A new approach for guaranteed state estimation by zonotopes. In *Proc. of the 18th IFAC World Congress*, Milan, Italy, 2011.

---

\*V.T.H. Le, C. Stoica and D. Dumur are with SUPELEC Systems Sciences (E3S) – Automatic Control Department, 3 rue Joliot Curie, F-91192, Gif-sur-Yvette cedex, France (e-mail: {vutuanhieu.le; cristina.stoica; didier.dumur}@supelec.fr

<sup>†</sup>T. Alamo and E.F. Camacho are with Department of Ingeniería de Sistemas y Automática, Universidad de Sevilla, Camino de los Descubrimientos, 41092 Sevilla, Spain (e-mail: alamo@cartuja.us.es, eduardo@esi.us.es