Bibliometric Analysis Of Active Disturbance Rejection Control

MSc. Fernando Jesús Regino Ubarnes[1], Msc July Andrea Gómez Camperos[2*], MSc. Haidee Yulady Jaramillo[3]

[1] Universidad Francisco de Paula Santander Seccional Ocaña, Facultad de Ingeniería, Grupo de Investigación (GINSTI) Ocaña, Norte de Santander, Colombia.

[2] Universidad Francisco de Paula Santander Seccional Ocaña, Estudiante de Doctorado en Automática de la Universidad de Pamplona, Facultad de Ingeniería, Grupo de Investigación (GINSTI) Ocaña, Norte de Santander, Colombia.

[3] Universidad Francisco de Paula Santander Seccional Ocaña, Estudiante de Doctorado Universidad Francisco Pontificia Bolivariana, Facultad de Ingeniería, Grupo de Investigación (GINSTI) Ocaña, Norte de Santander, Colombia.

E-mail*: July Andrea Gómez Camperos

ABSTRACT:

This paper describes the bibliometric analysis of control based on active disturbance rejection. The research was conducted in the Scopus database to identify academic participation on this topic. Based on a theoretical framework that resulted in 1268 articles from 1993 to 2022, networks of co-occurrences, co-authorships and actor countries were mapped, which made explicit the relationships in space and time, highlighting the countries France, the United States and China. The research becomes relevant for academia and civil society by highlighting research in emerging countries with different approaches and the possibility of gaining synergy with knowledge sharing, as well as best practices applied worldwide for the management of information systems in the field of automatic process control.

Keywords: Control, active disturbance rejection, differential flatness and differentially flat systems, modeling, tracking error

1. INTRODUCTION

The Active Disturbance Rejection Control ADRC is a control strategy capable of handling various parametric uncertainties and disturbances efficiently from the point of view of energy and implementation of a control system, because it is based on the use of two of the best features of modern control theory such as the representation of systems in canonical forms and state observers. From the point of view of control, it can be defined as the ability to identify and eliminate endogenous and exogenous disturbances in order to respond correctly to unpredicted

changes that occur in its context of action (Regino-Ubarnes et al., 2020).

The control system is expected to identify the disturbance correctly and accurately, however, the ADRC is also expected to overcome model uncertainties.

2. MATERIALS AND METHODS

Bibliometric analysis encompasses various mathematical and statistical methods to evaluate bibliometric data(GALVEZ, 2018). This review technique aims to understand the interrelationships between journal citations and summarizes the current state of the art of an existing or emerging research topic (Gan et al., 2022). The data used in a bibliometric analysis can be retrieved from different citation indexes for this case Scopus.

Initially, the ordered Scopus publications were examined through performance analysis. This method can descriptively examine the performance of publications, authors, institutions, countries and journals in relation to keyword queries entered in Scopus.

## 3. GPI CONTROL DESIGN AND SIMULATION RESULTS

Fundamental to understanding publication performance in a specific field is to observe the annual frequency of publication of scholarly articles (Goodell et al., 2022). A filter was applied, taking into account the wording of the titles and abstracts of the 1268 publications, in order to qualify only the publications that directly address the main topic, thus aligning, with the objectives of this research, such filter took into account the words "active rejection of disturbances", "differential flatness" and "Differentially flat systems" the filter was delimited between the years 1993 and 2022. Thus, publications referring to topics not aligned with the research were excluded.

Figure 1 depicts the annual publication rate of articles from 1993 to 2022, with a total of 1268 publications. The lowest number of publications (n = 2) was recorded in 1996. The data peaked in 2015 with 108 publications, of which 92 refer to engineering applications, approximately 40.5% and 37 refer to computer applications, approximately 16.3%.
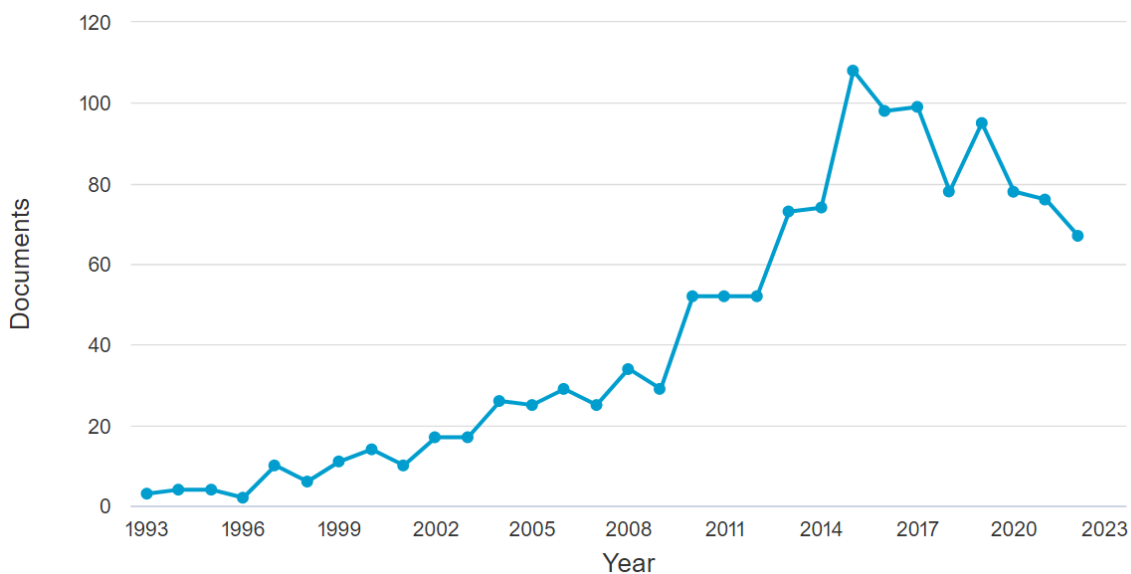

Figure 1. Publications by year

In the same sense, as shown in Figure 2, France with 251 publications, the United States with 244 publications and China with 178 publications are the countries with the most academic contributions on active disturbance rejection.
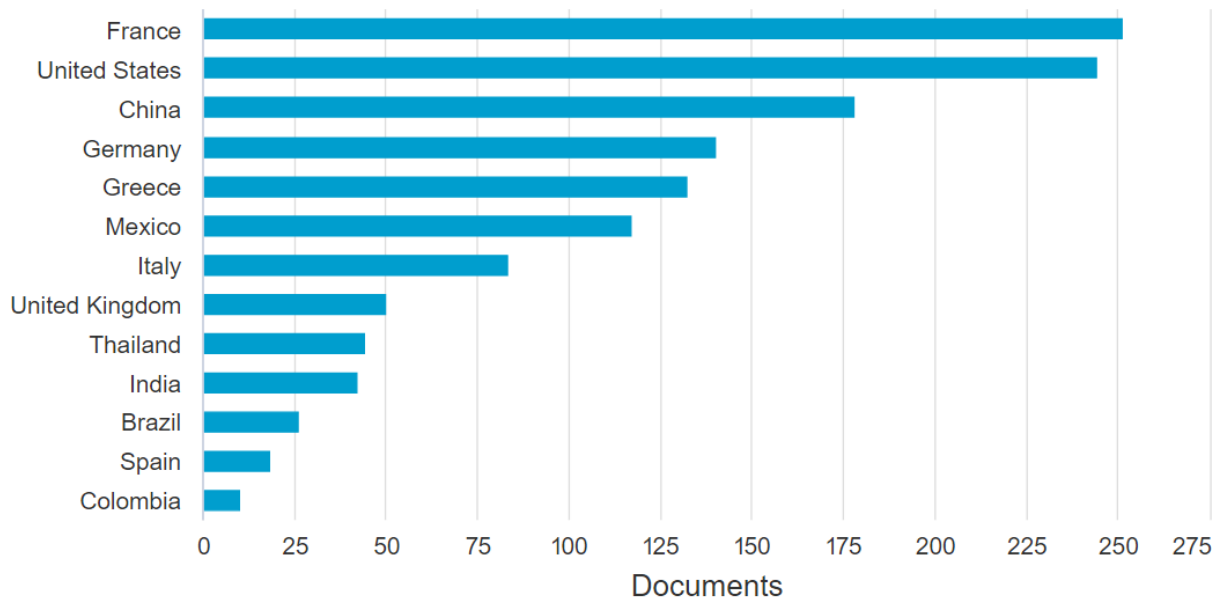

Figure 2. Publications by country

United States and China being the most closely related, as the publications are related to Germany, the United Kingdom, Greece, Mexico, Brazil and others.
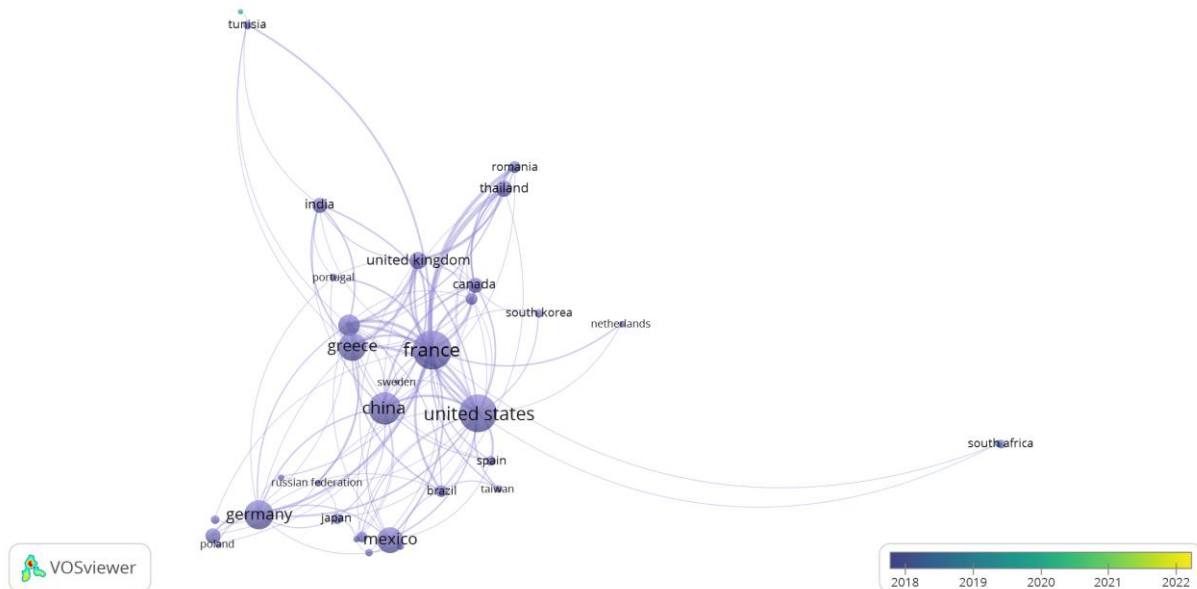
Figure 3. Co-authorship by country

Figure 4 shows the density of the network of relationships obtained from the number of occurrences, where red represents the highest density and blue the lowest. It is understood then, that the terms "differential flatness", "linear control system", "trajectory tracking" and "Computer simulation", are the most occurrences, therefore, central, denoting that the sample is

suitable for the study of the topic proposed in this work. According to (Liao et al., 2018) density visualization is particularly useful to get an overview of the overall structure of a map and draw attention to important areas.
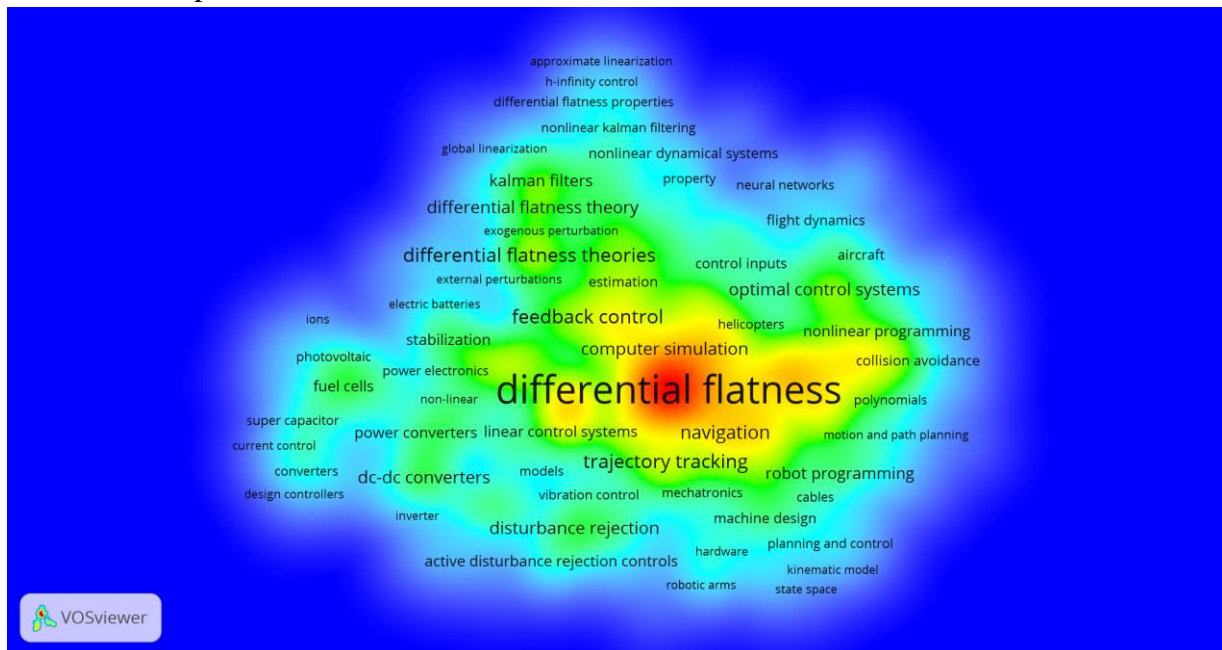
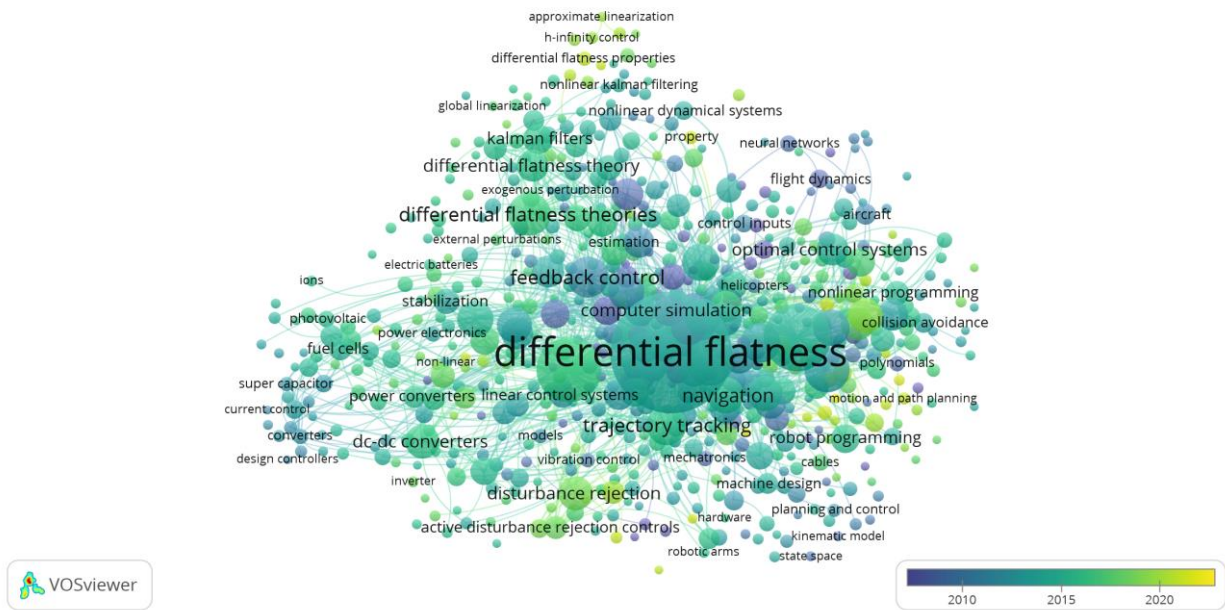
Figure 4. Relationship network density

Figure 5 presents the study of the network of relationships of the most recurrent terms over the years of the Filtered Sample, showing that the publications in fact revolve around "active rejection of disturbances", "differential flatness" and "Differentially flat systems".

In the years 2008 to 2011 the terms "linearization", "robustness" and "mathematical model" suggest the interest of studies on the trend towards robust controls, as studied by the authors (Aschemann & Schindele, 2008; Buccieri & Salzmann, 2008; Post et al., 2011; Rivera & Sawodny, 2010; Silva-Ortigoza et al., 2008).

In the years 2012 to 2014 the terms " State-Space Methods", " Trajectory tracking" and "optimal control system" suggest the interest of studies on the trend towards automatic control, as studied by (Rigatos, 2012; Rigatos & Rigatou, 2013; Thomas et al., 2014).

Between the years 2015 and 2018, the terms "fuell cell", "dc-dc converter" and "linear transformations" are the most remarkable as shown by (Aguilar-Ibañez et al., 2017; Silva-Navarro & Beltran-Carbajal, 2015; Silva Ortigoza et al., 2016; Thounthong et al., 2014; Zurita Bustamante et al., 2018).

From the year 2019, the evolution of the theme "active disturbance rejection" is present with the advancement of informative systems evidenced by the terms "disturbnce rejection", "opimal control system", according to studies by (Greco et al., 2022; Greeff & Schoellig, 2021; Thammasiriroj et al., 2019; Xu et al., 2020).

Figure 5. Relationship network of the most recurrent terms

4. CONCLUSIONS

The selection of keywords based on preliminary research in various academic and non-academic databases guided the construction of the theoretical framework in which the entire research was developed. The various synonyms found, which provide a significant breadth of the results located in the Scopus database, are striking.

The theme "Active rejection of disturbances" investigated then in a comprehensive manner, had the intention of analyzing bibliometrics, with the objective of searching for patterns through the network of semantic relationships, authors and countries. In this sense, it was observed that the topic of Active Disturbance Rejection, differential flatness in the area of control, is widely explored among the countries France, United States and China.

REFERENCES

Aguilar-Ibañez, C., Sira-Ramirez, H., & Acosta, J. Á. (2017). Stability of active disturbance rejection control for uncertain systems: A Lyapunov perspective. International Journal of Robust and Nonlinear Control, 27(18), 4541–4553. https://doi.org/https://doi.org/10.1002/rnc.3812

Aschemann, H., & Schindele, D. (2008). Sliding-Mode Control of a High-Speed Linear Axis Driven by Pneumatic Muscle Actuators. IEEE Transactions on Industrial Electronics, 55(11), 3855–3864. https://doi.org/10.1109/TIE.2008.2003202

Buccieri, D., & Salzmann, C. (2008). Jet-Scheduling Control for SpiderCrane : Experimental Results Jet-Scheduling Control for SpiderCrane : Experimental Results. January.

GALVEZ, C. (2018). Análisis de co-palabras aplicado a los artículos muy citados en Biblioteconomía y Ciencias de la Información (2007-2017). Transinformação, 30(3), 277–286. https://doi.org/10.1590/2318-08892018000300001

Gan, Y., Li, D., Robinson, N., & Liu, J. (2022). Practical guidance on bibliometric analysis and

mapping knowledge domains methodology – A summary. European Journal of Integrative Medicine, 56, 102203. https://doi.org/10.1016/j.eujim.2022.102203

Goodell, J. W., Kumar, S., Lahmar, O., & Pandey, N. (2022). A bibliometric analysis of cultural finance. International Review of Financial Analysis, 102442. https://doi.org/10.1016/j.irfa.2022.102442

Greco, L., Mounier, H., & Bekcheva, M. (2022). An approximate characterisation of the set of feasible trajectories for constrained flat systems. Automatica, 144. https://doi.org/10.1016/j.automatica.2022.110484

Greeff, M., & Schoellig, A. P. (2021). Exploiting differential flatness for robust learning-based tracking control using gaussian processes. IEEE Control Systems Letters, 5(4), 1121 – 1126. https://doi.org/10.1109/LCSYS.2020.3009177

Liao, H., Tang, M., Luo, L., Li, C., Chiclana, F., & Zeng, X.-J. (2018). A Bibliometric Analysis and Visualization of Medical Big Data Research. Sustainability, 10(2), 166. https://doi.org/10.3390/su10010166

Post, B. K., Mariuzza, A., Book, W. J., & Singhose, W. (2011). Flatness-Based Control of Flexible Motion Systems. ASME 2011, 843–850. https://doi.org/10.1115/DSCC2011-6099

Regino-Ubarnes, F. J., Espinel-Blanco, E. E., & Gómez-Camperos, J. A. (2020). Design of a discrete-time active disturbance rejection control strategy applied to the current loop of a boost bridgeless converter. Journal of Physics: Conference Series, 1704(1), 012014. https://doi.org/10.1088/1742-6596/1704/1/012014

Rigatos, G. G. (2012). Derivative-free Kalman Filtering for autonomous navigation of unmanned ground vehicles. 2012 1st International Conference on Systems and Computer Science (ICSCS), 1–6. https://doi.org/10.1109/IConSCS.2012.6502454

Rigatos, G. G., & Rigatou, E. G. (2013). A derivative-free nonlinear Kalman filtering approach to estimation of wave-type dynamics in neurons' membrane. AIP Conference Proceedings, 1558(1), 2533–2538. https://doi.org/10.1063/1.4826057

Rivera, G., & Sawodny, O. (2010). Flatness-Based Tracking Control and Nonlinear Observer for a Micro Aerial Quadcopter. AIP Conference Proceedings, 1281(1), 386–389. https://doi.org/10.1063/1.3498483

Silva-Navarro, G., & Beltran-Carbajal, F. (2015). A variable frequency vibration absorption approach in flexible mechanical structures. 2015 12th International Conference on Electrical Engineering, Computing Science and Automatic Control (CCE), 1–5. https://doi.org/10.1109/ICEEE.2015.7357986

Silva-Ortigoza, R., Silva-Ortigoza, G., Hernandez-Guzman, V. M., Barrientos-Sotelo, V. R., Albarran-Jimenez, J. M., & Silva-Garcia, V. M. (2008). Trajectory Tracking in a Mobile Robot without Using Velocity Measurements for Control of Wheels. IEEE Latin America Transactions, 6(7), 598–607. https://doi.org/10.1109/TLA.2008.4917431

Silva Ortigoza, R., Garcia Sanchez, J. R., Hernandez Guzman, V. M., Marquez Sanchez, C., & Marcelino Aranda, M. (2016). Trajectory Tracking Control for a Differential Drive Wheeled Mobile Robot Considering the Dynamics Related to the Actuators and Power Stage. IEEE Latin America Transactions, 14(2), 657–664. https://doi.org/10.1109/TLA.2016.7437207

Thammasiriroj, W., Mungporn, P., Yodwong, B., Nahid-Mobarakeh, B., Pierfederici, S., & Thounthong, P. (2019). Differential Flatness-Based Energy/Current Cascade Control for Multiphase Interleaved Boost Fuel Cell Converter. 2019 Research, Invention, and Innovation

Congress (RI2C), 1–4. https://doi.org/10.1109/RI2C48728.2019.8999904

Thomas, J., Loianno, G., Sreenath, K., & Kumar, V. (2014). Toward image based visual servoing for aerial grasping and perching. 2014 IEEE International Conference on Robotics and Automation (ICRA), 2113–2118. https://doi.org/10.1109/ICRA.2014.6907149

Thounthong, P., Sikkabut, S., Mungporn, P., Piegari, L., Nahid-Mobarakeh, B., Pierfederici, S., & Davat, B. (2014). DC bus stabilization of Li-Ion battery based energy storage for hydrogen/solar power plant for autonomous network applications. 2014 IEEE Industry Application Society Annual Meeting, 1–8. https://doi.org/10.1109/IAS.2014.6978368

Xu, L., Huangfu, Y., Li, Q., Xie, R., Liu, Y., & Ma, R. (2020). Research on Robust Control of High Gain DC-DC Converter for Fuel Cell Based on Differential Flatness Theory; [基于微分平坦理论的燃料电池用高增益DC-DC变换器鲁棒控制研究]. Zhongguo Dianji Gongcheng Xuebao/Proceedings of the Chinese Society of Electrical Engineering, 40(21), 6828 – 6838. https://doi.org/10.13334/j.0258-8013.pcsee.200478

Zurita Bustamante, E. W., Sira-Ramírez, H., & Linares-Flores, J. (2018). An equivalence between the ADRC and the Flat filtering controllers: A case study in double buck converter. 2018 14th International Conference on Power Electronics (CIEP), 188–193. https://doi.org/10.1109/CIEP.2018.8573339