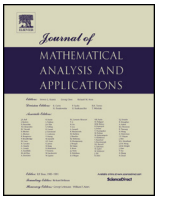
J. Math. Anal. Appl. 496 (2021) 124818

Contents lists available at ScienceDirect

Journal of Mathematical Analysis and Applications

www.elsevier.com/locate/jmaa



Limit cycles from a monodromic infinity in planar piecewise linear systems

Emilio Freire [a], Enrique Ponce [a], Joan Torregrosa [b,c,*], Francisco Torres [a]

[a] *Departamento Matemática Aplicada II, E.T.S. Ingeniería, Universidad de Sevilla, Camino de los Descubrimientos, 41092 Sevilla, Spain*
[b] *Departament de Matemàtiques, Universitat Autònoma de Barcelona, 08193 Cerdanyola del Vallès, Barcelona, Spain*
[c] *Centre de Recerca Matemàtica, Campus de Bellaterra, 08193 Cerdanyola del Vallès, Barcelona, Spain*

ARTICLE INFO

Article history:
Received 9 May 2020
Available online 26 November 2020
Submitted by Y. Huang

Keywords:
Planar piecewise linear systems
Bifurcation from infinity
Limit cycles
Centers

ABSTRACT

Planar piecewise linear systems with two linearity zones separated by a straight line and with a periodic orbit at infinity are considered. By using some changes of variables and parameters, a reduced canonical form with five parameters is obtained. Instead of the usual Bendixson transformation to work near infinity, a more direct approach is introduced by taking suitable coordinates for the crossing points of the possible periodic orbits with the separation straight line. The required computations to characterize the stability and bifurcations of the periodic orbit at infinity are much easier. It is shown that the Hopf bifurcation at infinity can have degeneracies of co-dimension three and, in particular, up to three limit cycles can bifurcate from the periodic orbit at infinity. This provides a new mechanism to explain the claimed maximum number of limit cycles in this family of systems. The centers at infinity classification together with the limit cycles bifurcating from them are also analyzed.

1. Introduction and main results

The analysis of piecewise linear systems is nowadays an active field of research since certain modern devices are well-modeled by this class of systems, see [10]. Even for the simplest situation, as is the case of the aggregation of two planar linear systems, there are still unsolved problems; for instance, it is known that such discontinuous piecewise linear systems can have three limit cycles (see, for instance, [4,16,20,24,25]) but we still do not know if three is indeed the maximum number for them.

In the analysis of the dynamical richness in a differential system, an interesting source of knowledge comes from the study of all possible bifurcations that the system can undergo. Furthermore, it should be emphasized the relevance of including in such a bifurcation study the possible bifurcations from infinity.

* Corresponding author.
E-mail addresses: efrem@us.es (E. Freire), eponcem@us.es (E. Ponce), torre@mat.uab.cat (J. Torregrosa), ftorres@us.es (F. Torres).

https://doi.org/10.1016/j.jmaa.2020.124818
0022-247X/