

Zeitschrift: L'Enseignement Mathématique
Herausgeber: Commission Internationale de l'Enseignement Mathématique
Band: 55 (2009)
Heft: 1-2

Artikel: Capture pursuit games on unbounded domains
Autor: Alexander, S. / Bishop, R. / Ghrist, R.

Bibliographie

DOI: <https://doi.org/10.5169/seals-110097>

Nutzungsbedingungen

Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Siehe Rechtliche Hinweise.

Conditions d'utilisation

L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. Voir Informations légales.

Terms of use

The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. See Legal notice.

Download PDF: 17.05.2025

ETH-Bibliothek Zürich, E-Periodica, <https://www.e-periodica.ch>

Other scenarios for uncertain information include those in which the pursuers do not admit an initial all-to-all communication round, but rather communicate with pursuers which are sufficiently close. Far-off pursuers cannot be reached. This and similar problems touch on many ideas currently in play in the control theory literature on distributed consensus with limited/faulty communication [35].

REMARK 28 (*Other noncooperative pursuit games*). There are numerous examples of pursuit-evasion games beyond the *Lion & Man* setting: see [12, 25] for an overview. We mention in particular the case considered by Isaacs [12] in which the evader’s goal is to reach a specified subset of the domain. More recent entries in the literature consider pursuit games in which capture means not physical coincidence, but rather visibility — the pursuer wins when there is a line-of-sight to the evader. For results in this genre, see [34, 9]. More recently, much attention has been paid to probabilistic techniques in pursuit games: see [13, 14, 37].

Stepping back from the game-theoretic perspective, one can consider a pursuit-evasion game as a form of cooperative consensus problem, where a “swarm” of pursuers attempts to reach positional consensus with an evasive “leader”. Consensus problems have received a great deal of attention recently from the control-theory community, with motivation from biologically observed swarming phenomena. Several authors [5, 35, 23] have given decentralized algorithms for reaching consensus in a variety of contexts.

REFERENCES

- [1] ALEXANDER, S., R. BISHOP and R. GHRIST. Pursuit and evasion in non-convex domains of arbitrary dimension. In: *Proc. Robotics, Systems and Science*, 2006.
- [2] ALONSO, L., A. S. GOLDSTEIN and E. M. REINGOLD. “Lion and man”: upper and lower bounds. *ORSA J. Comput.* 4 (1992), 447–452.
- [3] BOUGUER, P. Sur de nouvelles courbes ausquelles on peut donner le nom de lignes de poursuite. *Mémoires de l’Académie Royale des Sciences* (1732), 1–14.
- [4] CHIKRII, A. A. and P. V. PROKOPOVICH. Simple pursuit of one evader by a group. *Cybernet. Systems Anal.* 28 (1992), 438–444. Translated from *Kibernet. Sistem. Anal.* 3 (1992), 131–137.
- [5] CORTÉS, J. and F. BULLO. Coordination and geometric optimization via distributed dynamical systems. *SIAM J. Control Optim.* 44 (2005), 1543–1574.

- [6] CROFT, H. T. "Lion and Man": a postscript. *J. London Math. Soc.* 39 (1964), 385–390.
- [7] DANZER, L., B. GRÜNBAUM and V. KLEE. Helly's theorem and its relatives. In: Proc. Sympos. Pure Math. VII, 101–180. Amer. Math. Soc., 1963.
- [8] FLYNN, J. Lion and man: the general case. *SIAM J. Control* 12 (1974), 581–597.
- [9] GUIBAS, L. J., J.-C. LATOMBE, S. M. LAVALLE, D. LIN and R. MOTWANI. A visibility-based pursuit-evasion problem. *Internat. J. Comput. Geom. Appl.* 9 (1999), 471–493.
- [10] HOVAKIMYAN, N. and A. MELIKYAN. Geometry of pursuit-evasion on second order rotation surfaces. *Dynam. Control* 10 (2000), 297–312.
- [11] IBRAGIMOV, G. I. On a game of optimal pursuit of one evader by several pursuers. *Prikl. Mat. Mekh.* 62 (1998), 199–205; translation in *J. Appl. Math. Mech.* 62 (1998), 187–192.
- [12] ISAACS, R. *Differential Games. A Mathematical Theory with Applications to Warfare and Pursuit, Control and Optimization..* John Wiley & Sons, Inc., New York-London-Sydney, 1965.
- [13] ISLER, V., S. KANNAN and S. KHANNA. Locating and capturing an evader in a polygonal environment. In: *Sixth International Workshop on the Algorithmic Foundations of Robotics*, 2004.
- [14] ISLER, V., D. SUN. and S. SASTRY. Roadmap based pursuit-evasion and collision avoidance. In: *Proc. Robotics, Systems, & Science*, 2005.
- [15] IVANOV, R. P. Theorem on the alternative in simple pursuit-evasion and optimality on a half space. *Serdica Math. J.* 10 (1984), 397–411.
- [16] JANKOVIĆ, V. About a man and lions. *Mat. Vesnik* 2 (1978), 359–361.
- [17] KOPPARTY, S. and C. V. RAVISHANKAR. A framework for pursuit evasion games in \mathbf{R}^n . *Inform. Process. Lett.* 96 (2005), 114–122.
- [18] KOVSHOV, A. The simple pursuit by a few objects on the multidimensional sphere. In: *Game Theory & Applications II*, L. Petrosjan and V. Mazalov, eds., 27–36. Nova Science Publ., 1996.
- [19] LÊ, N.-M. On determining optimal strategies in pursuit games in the plane. *Theoret. Comput. Sci.* 197 (1998), 203–234.
- [20] LEWIN, J. The lion and man problem revisited. *J. Optim. Theory Appl.* 49 (1986), 411–430.
- [21] LITTLEWOOD, J. E. *A Mathematician's Miscellany*. Methuen & Co., London, 1953. Revised edition published as *Littlewood's Miscellany*, Cambridge University Press, Cambridge, 1986.
- [22] MELIKYAN, A. A. *Generalized Characteristics of First Order PDEs*. Applications in optimal control and differential games. Birkhäuser, Boston, 1998.
- [23] MOREAU, L. Stability of multiagent systems with time-dependent communication links. *IEEE Trans. Automat. Control* 50 (2005), 169–182.
- [24] MORLEY, F. V. A curve of pursuit. *Amer. Math. Monthly* 28 (1921), 54–61.
- [25] NAHIN, P. J. *Chases and Escapes. The Mathematics of Pursuit and Evasion*. Princeton University Press, Princeton, 2007.
- [26] PARSONS, T. Pursuit evasion in a graph. In: *Theory & Application of Graphs*, Y. Alavi and D. Lick, eds., 426–441. Springer-Verlag, 1976.

- [27] REIF, J. H. and S. R. TATE. Continuous alternation: the complexity of pursuit in continuous domains. *Algorithmica* 10 (1993), 156–181.
- [28] RIKHSIEV, B. B. Optimality of pursuit time in an n -person differential game with simple motion. *Izv. Akad. Nauk UzSSR Ser. Fiz.-Mat. Nauk* 4 (1984), 37–39.
- [29] ROCKAFELLAR, R. T. *Convex Analysis*. Princeton Mathematical Series 28. Princeton University Press, Princeton, 1970.
- [30] ROTE, G. Pursuit-evasion with imprecise target location. In: *Proceedings of the 14th Annual ACM-SIAM Symposium on Discrete Algorithms* (Baltimore, 2003), 747–753. ACM, New York, 2003.
- [31] SATIMOV, N. YU. and A. SH. KUCHKAROV. Deviation from encounter with several pursuers on a surface. *Uzbek. Mat. Zh.* 1 (2001), 51–55.
- [32] SATIMOV, N. YU. and A. SH. KUCHKAROV. On the solution of a model differential pursuit-evasion game on a sphere. *Uzbek. Mat. Zh.* 1 (2000), 45–50.
- [33] SGALL, J. Solution of David Gale’s lion and man problem. *Theoret. Comput. Sci.* 259 (2001), 663–670.
- [34] SUZUKI, I. and M. YAMASHITA. Searching for a mobile intruder in a polygonal region. *SIAM J. Comput.* 21 (1992), 863–888.
- [35] TANNER, H. G., A. JADBABAIE and G. J. PAPPAS. Flocking in fixed and switching networks. *IEEE Trans. Automat. Control* 52 (2007), 863–868.
- [36] VAGIN, D. A. and N. N. PETROV. The problem of the pursuit of a group of rigidly coordinated evaders. *Izv. Akad. Nauk Teor. Sist. Upr.* 5 (2001), 75–79.
- [37] VIDAL, R., O. SHAKERNIA, H. J. KIM, D. H. SHIM and S. SASTRY. Probabilistic pursuit-evasion games: theory, implementation, and experimental evaluation. *IEEE Trans. Robotics Aut.* 18 (2002), 662–669.
- [38] WU, H. The spherical images of convex hypersurfaces. *J. Differential Geom.* 9 (1974), 279–290.

(Reçu le 3 janvier 2008)

S. Alexander

R. Bishop

Department of Mathematics
 University of Illinois
 Urbana, IL 61801
 U. S. A.
e-mail : sba@math.uiuc.edu, bishop@math.uiuc.edu

R. Ghrist

Departments of Mathematics and
 Electrical/Systems Engineering
 University of Pennsylvania
 Philadelphia, PA 19104
 U. S. A.
e-mail : ghrist@math.upenn.edu