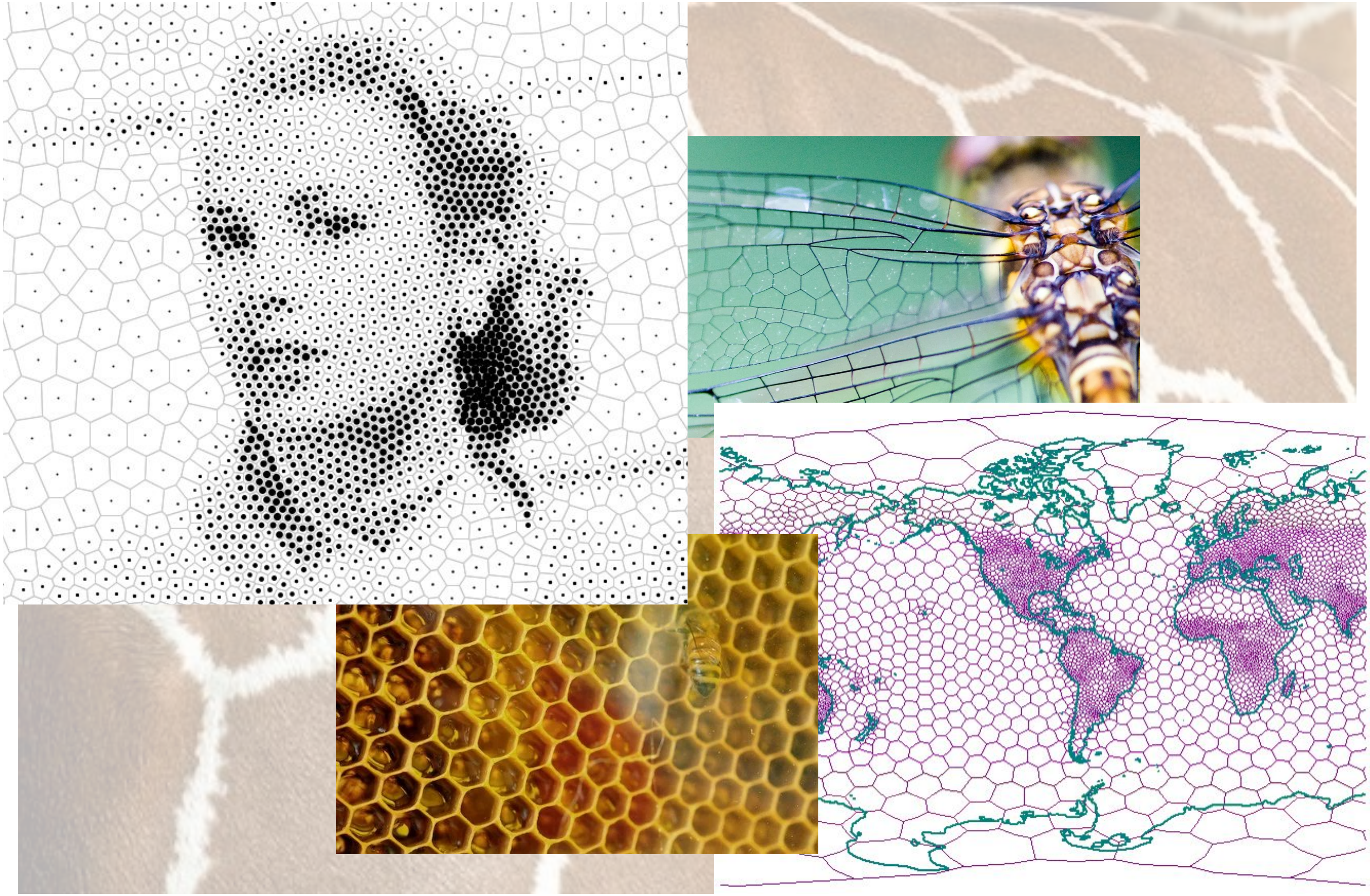


Swarm Robotics @ Multi-Robot Systems @ MURGCV

Universidad Zaragoza

Voronoi diagram

From Wikipedia, the free encyclopedia

In mathematics, a **Voronoi diagram** is a
each of a given set of objects. In the sim
many points in the plane (called seeds,
is a corresponding region, called **Voron**
closer to that seed than to any other. Th
to its Delaunay triangulation.

The Voronoi diagram is named after Ge
tessellation, a **Voronoi decompositio**
tessellation (after Peter Gustav Lejeun
as **Thiessen polygons**.[1][2][3] Voronoi d
applications in many fields, mainly in sci
art.[4][5]

Q. Du, V. Faber, M. Gunzburger (1999), C

Applications [edit]

See also: Delaunay triangulation § Applications

Humanities [edit]

- In classical archaeology, specifically art history, the symmetry of statue heads is analyzed to determine the type of statue a severed h

Natural sciences [edit]

- In biology, Voronoi diagrams are used to model a number of different biological structures, including cells[20] and bone microarchitect
- In hydrology, Voronoi diagrams are used to calculate the rainfall of an area, based on a series of point measurements. In this usage,
- In ecology, Voronoi diagrams are used to study the growth patterns of forests and forest canopies, and may also be helpful in develop
- In computational chemistry, ligand-binding sites are transformed into Voronoi diagrams for machine learning applications (e.g., to clas deformation density method.
- In astrophysics, Voronoi diagrams are used to generate adaptative smoothing zones on images, adding signal fluxes on each one. Th
- In computational fluid dynamics, the Voronoi tessellation of a set of points can be used to define the computational domains used in f
- In computational physics, Voronoi diagrams are used to calculate profiles of an object with Shadowgraph and proton radiography in H

Health [edit]

- In medical diagnosis, models of muscle tissue, based on Voronoi diagrams, can be used to detect neuromuscular diseases.[22]
- In epidemiology, Voronoi diagrams can be used to correlate sources of infections in epidemics. One of the early applications of Voron whose residents had been using a specific water pump, and the areas with most deaths due to the outbreak.[26]

Engineering [edit]

- In polymer physics, Voronoi diagrams can be used to represent free volumes of polymers.
- In materials science, polycrystalline microstructures in metallic alloys are commonly represented using Voronoi tessellations. In island reciprocal (wavenumber) space of crystals which have the symmetry of a space group.
- In aviation, Voronoi diagrams are superimposed on oceanic plotting charts to identify the nearest airfield for in-flight diversion (see ET
- In architecture, Voronoi patterns were the basis for the winning entry for the redevelopment of The Arts Centre Gold Coast.[31]
- In urban planning, Voronoi diagrams can be used to evaluate the Freight Loading Zone system.[32]
- In mining, Voronoi polygons are used to estimate the reserves of valuable materials, minerals, or other resources. Exploratory drillhol
- In surface metrology, Voronoi tessellation can be used for surface roughness modeling.[33]
- In robotics, some of the control strategies of multi-robot systems are based on the Voronoi partitioning of the environment.[34][35]

Geometry [edit]

- A point location data structure can be built
vector quantization, commonly used in data
- In geometry, Voronoi diagrams can be used
- Voronoi diagrams together with farthest-poi

Informatics [edit]

- In networking, Voronoi diagrams can be use
- In computer graphics, Voronoi diagrams are
- In autonomous robot navigation, Voronoi di
- In machine learning, Voronoi diagrams are
- In user interface development, Voronoi patt

34. ^ Cortes, J.; Martinez, S.; Karatas, T.; Bullo, F. (April 2004). "Coverage control for mobile sensing networks". *IEEE Transactions on Robotics and Automation*. **20** (2): 243–255. doi:10.1109/TRA.2004.824698. ISSN 2374-958X.
35. ^ Teruel, Enrique; Aragues, Rosario; López-Nicolás, Gonzalo (April 2021). "A Practical Method to Cover Evenly a Dynamic Region With a Swarm". *IEEE Robotics and Automation Letters*. **6** (2): 1359–1366. doi:10.1109/LRA.2021.3057568. ISSN 2377-3766.

Civics and planning [edit]

- In Melbourne, government school students are always eligible to attend the nearest primary school or high school to where they live,

Bakery [edit]

- Ukrainian Pastry chef Dinara Kasko uses the mathematical principles of the Voronoi diagram to create silicone molds made with a 3D

Introducing the Voronoi partition

The Post-Office Problem

Coordinated Motion (Flocking) The "voronoids" approach

- J. Cortes *et al.* (2004), "Coverage control for mobile sensing networks," in IEEE Trans. Robotics and Automation 20 (2): 243-255
- M. Cao, C. Hadjicostis (2003), Distributed algorithms for Voronoi diagrams and application in ad-hoc networks. Technical report
- Y. Song, B. Wang, Z. Shi, K. R. Pattipati and S. Gupta (2013), "Distributed Algorithms for Energy-Efficient Even Self-Deployment in Mobile Sensor Networks," in IEEE Trans. Mobile Computing 13 (5): 1035-1047
- E. Teruel, R. Aragues, G. López-Nicolás (2018), "A distributed robot swarm control for dynamic region coverage" in Robotics and Autonomous Systems 119: 51-63
- E. Teruel, R. Aragues, G. López-Nicolás (2021), "A Practical Method to Cover Evenly a Dynamic Region With a Swarm," in IEEE Robotics and Automation Letters 6(2): 1359-1366

The nice features of CVT's

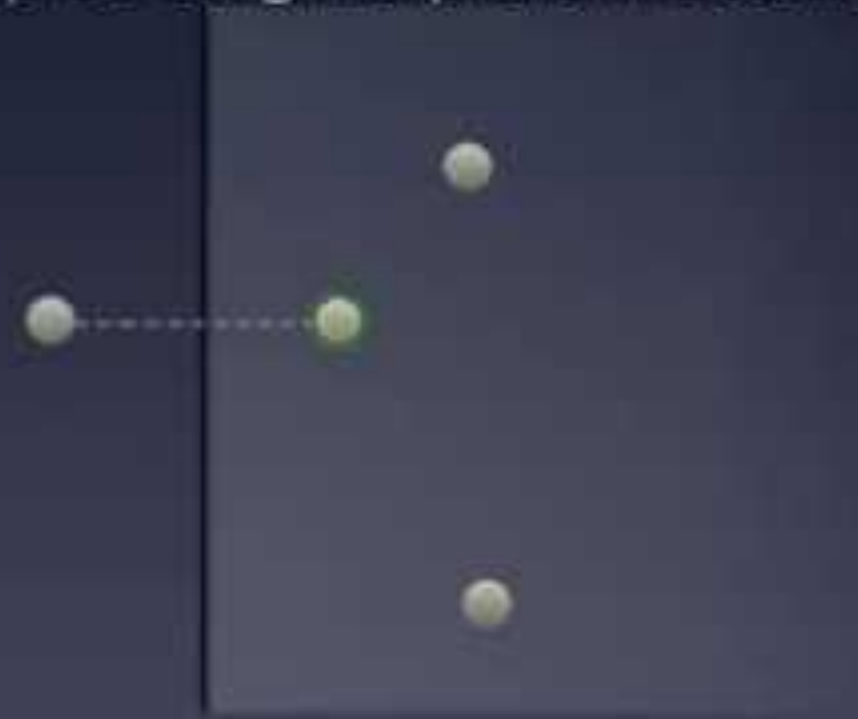
- A robust even distribution over an area
  - For whichever number of robots
  - Possibility to make it "proportional to interest"
- Inherently prevents collisions
- Distributed algorithm with little requirements
  - "Better" algorithms exist for centralized, or with not so little requirements (e.g., Hessian approx)
  - Closed geometrical computations (with uniform "interest density")
- "Fast" (short "rise time", but long "settling time")

Computing "my" Voronoi cell

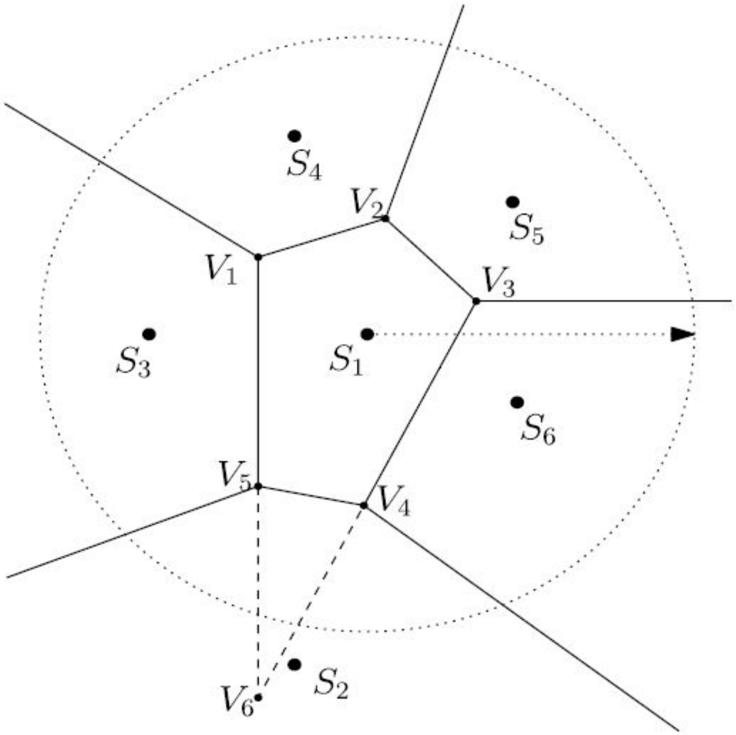
Voronoi Diagrams: Algorithms

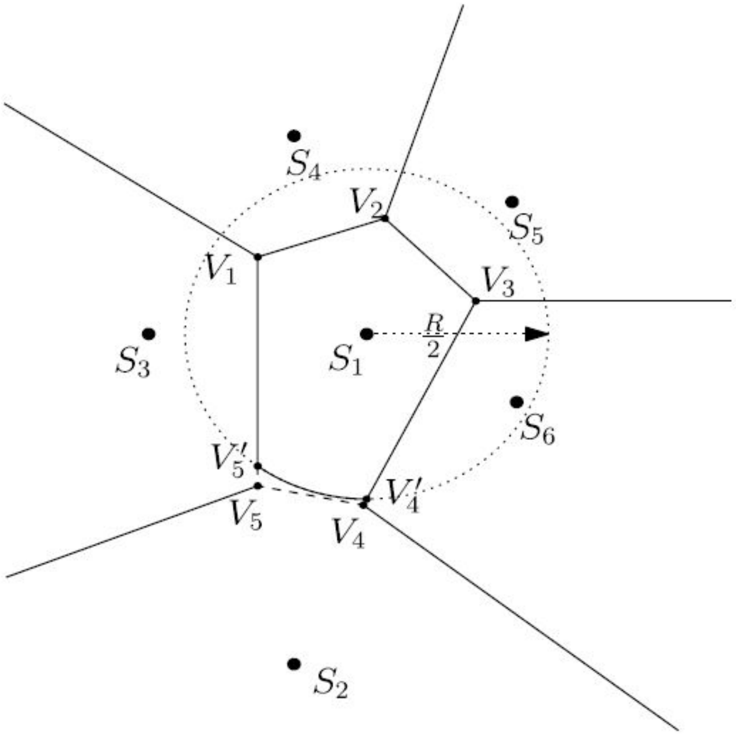
Algorithm

The concept is applied using half plane intersection.



Range limited Voronoi cells

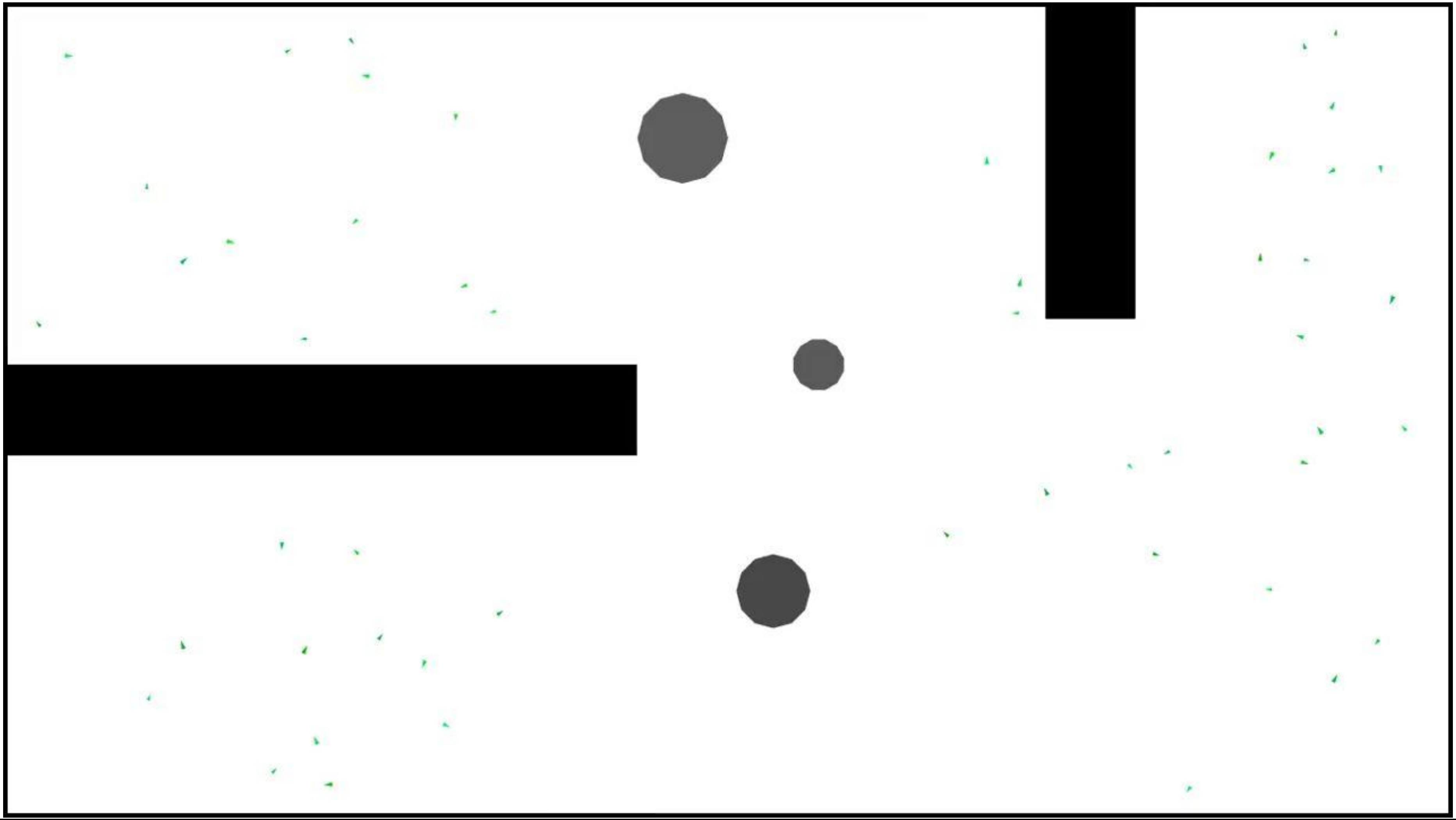




M. Cao, C. Hadjicostis (2003), Distributed algorithms for Voronoi diagrams and application in ad-hoc networks. Technical report

Covering a small convex area

Covering a small area with obstacles



Large and complex dynamic areas

The original question:

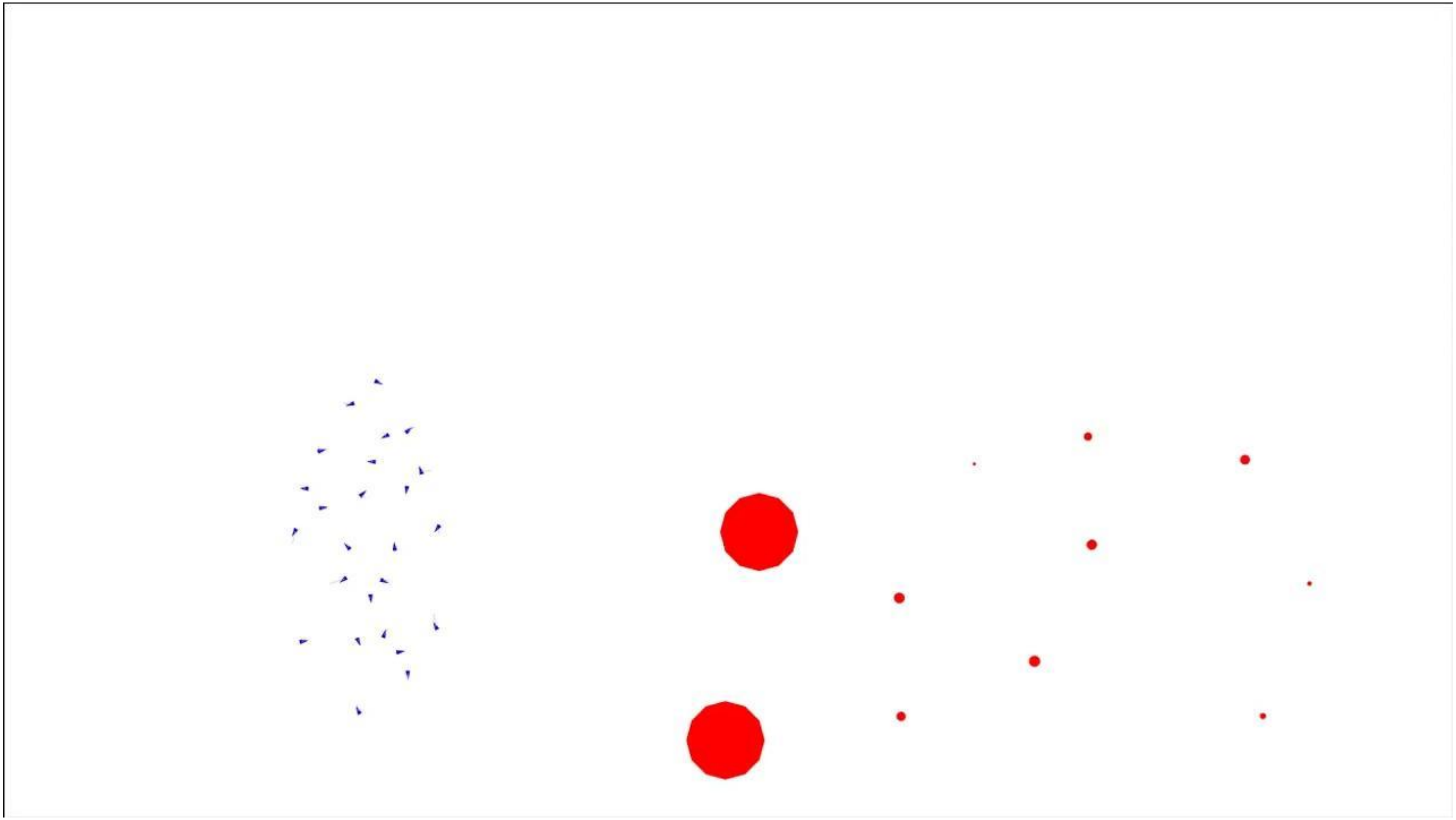
Is it possible to cover with a (near-)CVT “formation” a dynamic region that is fastly changing and moving to sweep the full dynamic area? How to overcome the slow convergence?

Our answer, to date:

- E. Teruel, R. Aragues, G. López-Nicolás (2018), “A distributed robot swarm control for dynamic region coverage” in Robotics and Autonomous Systems 119: 51-63
- E. Teruel, R. Aragues, G. López-Nicolás (2021), "A Practical Method to Cover Evenly a Dynamic Region With a Swarm," in IEEE Robotics and Automation Letters 6(2): 1359-1366

Area coverage with a MRS

Coming “soon”



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