M2 Internship subject – 2022/2023

Distance transform on cellular spaces and its computation

proposed by

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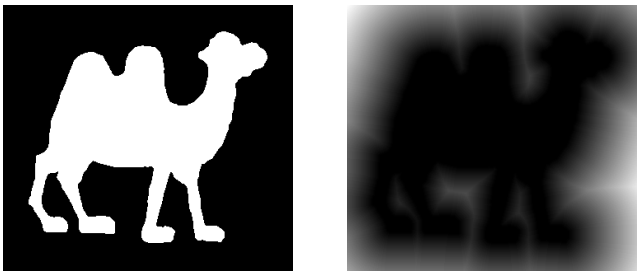
Description :
Distance transforms are an important tool in image processing used for many applications. Given a binary digital image, whose space can be seen as a (regular) cubical cellular space, its distance transform specifies the distance from each pixel to the nearest foreground pixel (see Fig. 1). Such distance transforms play a central role in comparing digital shapes, computing the medial axis of digital shapes, segmenting images into regions, etc. [1, 2].

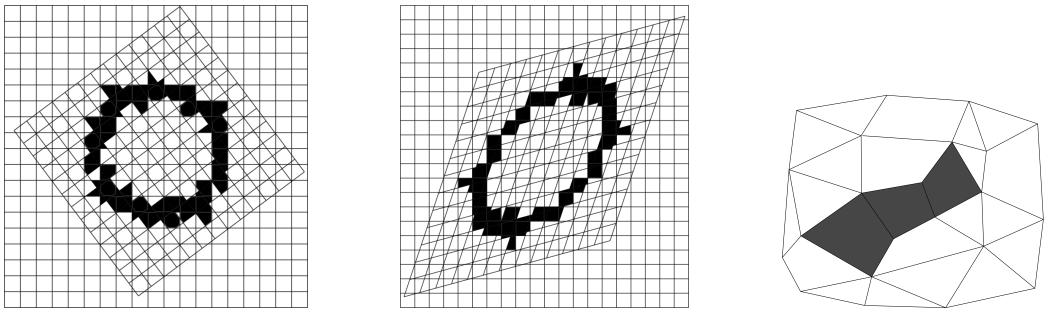


(a) (b)

FIGURE 1 – (a) A binary image (on a cubical cellular space) and (b) its distance transform.

There exist several algorithms for computing exact or approximate Euclidean distance transform in linear time with respect to image size in cubical cellular space [1, 3].

In this research internship, we aim at studying more general cases, namely irregular cellular spaces which are, for instance, generated by superimposition of two regular cellular spaces [4] or a Voronoi diagram [5] (see Fig. 2). More precisely, we focus on the basics of distances and on algorithms for computing distance transforms on such cellular spaces in an efficient manner. We first explore two-dimensional cases and then extend the study to higher dimensions.



(a) (b) (c)

FIGURE 2 – (a,b) Superimpositions of two cubical cellular spaces and two regular cellular spaces and (c) a polygonal cellular space.

References

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[2] R. Klette and A. Rosenfeld. *Digital geometry: Geometric methods for digital picture analysis*. Morgan Kaufmann, 2004.

[3] T. Strutz. The distance transform and its computation, 2021. arXiv:2106.03503.

[4] N. Passat, P. Ngo, Y. Kenmochi, and H. Talbot. Homotopic affine transformations in the 2D Cartesian grid. *Journal of Mathematical Imaging and Vision*, 64(7):786–806, 2022.

[5] B. Telsang and S. M. Djouadi. Computation of centroidal Voronoi tessellations in high dimensional spaces. *IEEE Control Systems Letters*, 6:3313–3318, 2022.