Abstract

PhD Thesis of Shyamosree Pal submitted on September 30, 2011, at IIT Kharagpur

Thesis Title: ***Curvature, Circularity, and Related Applications: A Digital-geometric Perspective***

In this thesis, we have reported some new theoretical findings, empirical formulations, useful heuristics, and efficient algorithms related with discrete curvature and digital circularity, along with some practical applications. Though their exist several curvature estimation techniques, each of them has their limitations in the digital domain. We have proposed a novel technique for the estimation of discrete curvature, which is based on appropriate pairing of the constituent points of a digital curve and a few fundamental properties of digital straightness. The curvature estimated by this technique is quite effective in cubic approximation of curve-shaped objects and circular arc segmentation in digitized engineering drawings. The problem of circular arc segmentation is quite challenging and has intrigued researchers for last three decades. Several theoretical studies and practical experimentation have been done over the years. As an alternative solution, we have proposed a novel number-theoretic technique to determine whether a digital curve segment is digitally circular using the correspondence of its constituent runs of digital points with the square numbers in the integer interval. We have extended this idea for circular arc segmentation using the concept of approximate circularity and delimited cliques in the cuboid graph, which are all newly introduced in this thesis. Exhaustive experimentation have been done on several benchmark datasets, and the results furnished here demonstrate the efficiency, robustness, and accuracy of the algorithm. Since circular arc segmentation has to be performed in practice on document images containing graphics embedded in text, we have also presented a novel technique for text-graphics segmentation and graphics classification. Further, we have proposed a fast and efficient technique for empirical estimation of different circularity measures of real-world shapes using their isothetic covers, since such empirical measures find diverse applications in geology, biology, medical sciences, industrial processing, and many other fields. The thesis ends with future research directions and a few interesting problems related with digital circularity.