UNIVERSITI TEKNOLOGI MARA

MATHEMATICAL APPROXIMATION OF TUMOR AREA USING BEZIER BOUNDARY MODELLING AND NUMERICAL AREA COMPUTATION

NURAIN ARIESA BINTI ABU SAMAH

BSc

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ABSTRACT

It is crucial to have reliable measurement of tumor size for cancer diagnosis, staging and treatment planning. But in clinical practice, tumor size assessment still relies on unidimensional measurements that assume tumors are circular or elliptical shapes. However, tumor boundaries are often irregular and asymmetric which can lead to inaccurate area calculations. This study presents a mathematical framework in estimating the area of irregular tumors by integrating Computer-Aided Geometric Design (CAGD) boundary reconstruction with numerical area computation approaches. Tumor boundary points extracted from Magnetic Resonance Imaging (MRI) are reconstructed using Cubic Bezier curve and Cubic Trigonometric Bezier curve with additional shape parameters that allows enhanced curvature control without modifying the control points. The enclosed tumor area is first determined using Green's Theorem and subsequently approximated using the Trapezoidal Rule and the Shoelace Formula for variation of subintervals. Boundary reconstruction performance is assessed using Root Mean Square (RMSE) based on Euclidean distance while area estimation accuracy is evaluated through absolute and percentage errors compared with the Green's Theorem. In addition, the reconstructed boundaries are compared with an ellipse-based approximation to demonstrate the limitations of simplified geometric representations in capturing irregular tumor shapes. The findings are expected to indicate that Cubic Trigonometric Bezier modelling combined with numerical computation approached gives a more accurate and robust representation of irregular tumor boundaries than traditional geometric approximations. It is offering a practical mathematical approach to enhance tumor size assessment in biomedical imaging application.