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(57) Abstract :

Innovative automated road extraction system that addresses the complex task of identifying urban road features within high-resolution satellite images. By seamlessly integrating a series of advanced techniques, the proposed solution achieves a level of precision and efficiency previously unattainable. At the core of this novel framework lies a hypergraph-based pre-processing technique, meticulously designed to enhance image quality by eliminating noise and rectifying geometric distortions. This preparatory step sets the stage for subsequent stages, ensuring a robust foundation for accurate feature extraction. Our solution's unique prowess emerges from the fusion of the Canny edge detection algorithm with hypergraph integration. This amalgamation not only identifies edges exhibiting rapid changes in image intensity but also leverages hypergraph's intricate pixel relationships to enhance edge detection accuracy. The outcome is a robust edge detection process, forming a cornerstone for precise and comprehensive feature segmentation. Moving beyond edge detection, the proposed solution capitalizes on the power of the Hough Transform method for line extraction. This technique adeptly identifies linear line segments within detected edges, effortlessly accounting for variations in orientation and position. The method's adaptability enhances the system's capacity to accurately recognize straight road segments, elevating the overall fidelity of road feature extraction. An exemplary innovation of the proposed solution is the Progressive Probabilistic Hough Transform (PPHT), designed to address the critical task of parallel line extraction. This technique revolutionizes the identification of parallel road structures, a paramount consideration in urban environments. By accommodating gaps within predefined thresholds, PPHT excels at comprehensively identifying parallel road features, thereby bolstering the system's effectiveness in intricate urban settings. Moreover, the proposed solution presents a dedicated centerline extraction algorithm, serving as a refined culmination of the edge detection and line extraction stages. This algorithm exhibits precision in extracting road centerlines, offering a clear and concise representation of road features within complex urban landscapes. Through a harmonious integration of hypergraph-based pre-processing, Canny edge detection, Hough Transform-based line extraction, Progressive Probabilistic Hough Transform, and dedicated centerline extraction, the proposed solution reshapes the landscape of spatial data analysis. Its impact spans domains such as urban planning, traffic management, cartography, and driver assistance systems, redefining decision-making processes and propelling technological advancement.

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