

Medical Digital Image Preprocessing and Segmentation

Asiana Holloway Project Report

The goal of this project was to explore fundamental digital image preprocessing and segmentation techniques in the context of medical imaging. Preprocessing helps improve image clarity and quality, which is crucial for accurate segmentation of medical structures such as brain tissue. Segmentation allows isolation of regions of interest, such as potential tumors, making the images more useful for diagnostic support systems and AI model training.

This project helped me expand my knowledge in digital image processing, particularly in working with grayscale conversion, min-max normalization, and thresholding segmentation. On the technical side, I implemented pixel-level intensity transformations, applied normalization to enhance image contrast, and used thresholding techniques to extract regions of interest. By running these processes step-by-step, I gained hands-on experience with image enhancement, feature isolation, and evaluating image suitability for machine learning pipelines. These skills translate directly into real-world applications such as preparing medical images for AI model development and integrating preprocessing pipelines into clinical decision support systems.

The project began with grayscale conversion, which simplified the medical images by removing unnecessary color information. This not only reduced the computational cost of processing the images but also improved the accuracy of the subsequent segmentation steps by focusing solely on intensity values. Next, image stretching was performed using min-max normalization. By rescaling pixel values across the full grayscale range (0–255), this technique enhanced the contrast within the images, making subtle details in brain structures more visible and distinct. Finally, thresholding segmentation was applied to isolate regions of interest based on their intensity values. This approach effectively separated areas of different densities, which is particularly useful for detecting tumors or other abnormalities in medical scans.

The preprocessing steps significantly improved both the clarity and contrast of the medical images. After normalization, the enhanced visibility of anatomical structures made it easier to identify meaningful regions. Thresholding segmentation further refined the images by successfully isolating potential areas of interest, such as regions that could represent tumors. Overall, the resulting images demonstrated strong potential for use in AI model training. The clear contrast, high resolution, and effective segmentation provide the necessary quality for developing accurate models for brain tumor detection.

The knowledge and results gained from this project have direct relevance to real-world healthcare applications. For example, computer aided diagnosis (CAD) systems can benefit from these preprocessing and segmentation techniques by allowing radiologists to detect tumors more quickly and accurately. Similarly, the segmented and enhanced images provide high-quality training data for AI models, which are increasingly being used to support medical image classification and detection tasks. Beyond diagnostics, automated segmentation pipelines can be incorporated into clinical decision support systems to save time, reduce human error, and streamline workflows in routine radiology.

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practice. Finally, these methods provide a foundation for research in oncology, radiology, and AI-driven medical imaging, supporting innovation in areas such as tumor detection, disease progression tracking, and treatment planning.