AI-Driven Precision Radiation-Based Conservation Treatment for Cultural Heritage

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Keywords: Radiation-based conservation treatment, Artificial Intelligence (AI), Computed tomography (CT), Treatment planning system (TPS), Dose optimization

The preservation of cultural heritage faces significant challenges from biological degradation. With traditional chemical fumigants like Methyl Bromide (MB) facing strict global phase-outs due to environmental and health hazards, ionizing radiation has emerged as a promising alternative owing to its high penetration depth and effective sterilization capabilities. However, applying uniform irradiation often risks structural or chemical damage to delicate historical artifacts. This study introduces a highly customized, AI-driven framework that integrates automated technologies into radiation-based conservation treatments.

By utilizing high-resolution Computed Tomography (CT) imaging prior to irradiation, this system enables the accurate prediction and optimization of 3D dose distributions. Artificial Intelligence (AI) algorithms automate the segmentation of internal biological threats and structural vulnerabilities. Furthermore, AI-driven plan optimization and Monte Carlo-based dose calculations precisely control the delivery of radiation. This ensures that the minimum lethal dose is concentrated on target organisms while strictly maintaining the absorbed dose of surrounding sensitive materials below their maximum tolerance limits. Ultimately, this approach not only standardizes the disinfection process but also provides a safe, automated, and highly precise protocol for the effective conservation of global cultural heritage.

Acknowledgement

This research is supported by the Korea Heritage Service and the National Research Institute of Cultural Heritage (Project Name: Development and Standardization of Non-Destructive Precision Diagnosis and Customized Conservation Technology for Cultural Heritage, Project Number: RS-2026-25533783, Contribution Rate: 100%).