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M.Sc Artificial Intelligence

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[RESEARCH PROPOSAL OUTLINE]

A brief outline of the research proposal on the topic of my capstone project

Project Title:

Deep Learning-Based Synthetic-Computed Tomography (sCT) Generation in Radiotherapy

Significance to the Research Problem:

Radiotherapy is a crucial treatment modality for cancer patients, relying heavily on accurate CT images for planning and dosage calculations. However, repeated CT scans can be harmful due to radiation exposure and are often not feasible in certain situations. The research problem lies in the need for a reliable method to generate synthetic CT images from other imaging modalities, such as Magnetic Resonance Imaging (MRI) or Cone Beam Computed Tomography (CBCT), to enhance the accuracy and safety of radiotherapy planning.

This research aims to address this problem by developing a deep learning-based approach to generate synthetic CT images, enabling more precise radiotherapy planning without the need for additional CT scans.

Research Question:

Can deep learning techniques be effectively employed to generate synthetic CT images from alternative imaging modalities in radiotherapy, and can these synthetic images achieve sufficient accuracy for treatment planning?

Aims and Objectives:

Aim 1: To develop a deep learning model for synthetic CT image generation.

Objective 1.1: Collect and preprocess a diverse dataset of MRI/CBCT and corresponding CT images.

Objective 1.2: Implement and train a deep neural network architecture for synthetic CT generation.

Objective 1.3: Evaluate the model's performance using quantitative and qualitative measures.

Aim 2: To assess the clinical utility and accuracy of synthetic CT images in radiotherapy planning.

Objective 2.1: Compare the synthetic CT images with actual CT images in terms of anatomical accuracy.

Objective 2.2: Analyse the impact of synthetic CTs on radiotherapy planning and dose calculations.

Objective 2.3: Assess the clinical feasibility and safety of using synthetic CTs in patient treatment.

Key Literature Related to the Project:

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Research Design:

Data Collection: Gather a diverse dataset of paired MRI/CBCT and CT images from previous patients.

Data Preprocessing: Standardise and preprocess the data, including image registration and segmentation.

Deep Learning Model: Develop a deep neural network architecture, such as a convolutional neural network (CNN), for synthetic CT generation.

Training and Validation: Train the model on the dataset and validate its performance using metrics like mean squared error and structural similarity index.

Clinical Evaluation: Assess the utility of synthetic CT images in radiotherapy planning through a comparative study with actual CT images.

Ethical Approval: Seek ethical approval for the use of patient data and ensure compliance with data protection regulations.

Ethical Considerations and Risk Assessment:

Ethical approval will be sought to ensure patient data privacy and confidentiality. Risks associated with the project include potential errors in synthetic CT generation that could impact treatment planning. These risks will be mitigated through rigorous validation and clinical assessment. Informed consent will be obtained for the use of patient data.

Description of Artefact:

The primary artefact of this research will be a deep learning model capable of generating synthetic CT images from MRI data. Additionally, the research will produce a comprehensive report detailing the model's development, evaluation, and its potential impact on radiotherapy planning.

Timeline of Proposed Activities:

Month 1: Data collection and preprocessing

Month 1-2: Model development and training

Month 3: Model validation and performance evaluation

Month 4: Clinical assessment and ethical approval application

Month 4-5: Final analysis and report writing

Month 5-6: Dissemination of research findings and potential publication

Conclusion:

This proposed research aims to make a significant contribution to the field of radiotherapy by providing a reliable and safe method for generating synthetic CT images, ultimately improving the accuracy and quality of patient treatment planning.