Intro to Artificial Intelligence (COMP 8700)

Project Proposal of "Cardiomegaly Detection from Chest X-Rays using CNN and Transfer Learning Algorithms"

Group - 9

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1. Overview

Cardiomegaly, or an enlarged heart, is a common medical condition that can be a symptom of a number of underlying heart conditions, including heart failure or stroke. Coronary artery disease, the most common cause of cardiomegaly, affects a large number of people. Congestive heart failure, which is frequently caused by a dilated heart, is the leading cause of hospitalization in the United States for people over the age of 65. Therefore, detecting cardiomegaly early is critical for effective treatment and better outcomes. The most commonly used method for detecting cardiomegaly is a chest x-ray, and the cardiothoracic ratio (CTR) has been used as an important tool for estimating heart size, but radiologists' manual interpretation is prone to error and subjectivity. Consequently, deep learning models for the automatic detection of cardiomegaly from chest X-rays are employed to improve the accuracy and efficiency of the diagnosis.

This project will deliver a comparative analysis of various deep-learning models for detecting cardiomegaly from chest X-rays. The project's aim is to evaluate the performance of state-of-the-art models, such as Wide ResNet, Inception V3, EfficientNet, and MobileNet V3 / [custom/hybrid model], and compare their individual performances with each other. The project is a comparative analysis of some of the already existing models and a custom hybrid model that we have created.

The results of the project can be utilized by academic research institutions as a reference for the development of future deep-learning models of cardiomegaly detection. Additionally, some of the potential customers for this project could be healthcare organizations, medical imaging centres, Radiology departments, and Medical technology companies.

1.1 Applications

The comparative analysis of different deep learning models in detecting cardiomegaly has the following applications:

- Computer-aided diagnosis (CAD) systems: As a result of this research, computer-aided diagnostic systems for cardiomegaly detection from chest X-rays could be designed.

These systems can aid radiologists in the interpretation of chest X-rays and increase the precision and effectiveness of the diagnostic procedure.

- Clinical decision support systems: The outcomes of this experiment can be utilised to create clinical decision support systems for cardiomegaly identification, which can give medical professionals more information to help with patient diagnosis and treatment.
- Medical imaging research: By comparing the effectiveness of several deep learning models for cardiomegaly detection, the results of this project can benefit the field of medical imaging research, which can lead to earlier and more accurate diagnoses, improved patient outcomes, and better health outcomes overall.

1.2 Methodology

The following methodology is followed to implement this project:

- Data Collection: Obtaining a public dataset of a sizable collection of chest X-rays with diagnoses of cardiomegaly.
- Model selection and implementation: The deep learning models Wide ResNet, Inception V3, EfficientNet, and MobileNet V3 / [custom/hybrid model] are selected and required to be implemented using popular deep learning frameworks.
- Model training and evaluation: Training the models on the obtained dataset and evaluating the model based on its accuracy, PPV (Positive Predictive Value), NPV (Negative Predictive Value), sensitivity and specificity.
- Comparison and analysis: Compare the different deep learning models used in the detection of cardiomegaly based on their performance.

1.3 Literature Review

The use of deep learning techniques for the identification of cardiomegaly is becoming more and more popular, according to some of the most current research articles on the subject. These studies demonstrate the efficiency with which computer-aided diagnostic (CAD) systems based on convolutional neural networks (CNNs) can recognise cardiomegaly in a range of imaging modalities, including CT, MRI, ECG, and chest X-ray images.

In the paper "Study of cardiomegaly using chest x-ray" by Alghamdi, S. S., 2020, the authors found high accuracy and sensitivity results, demonstrating the potential of deep learning for the

detection of cardiomegaly. The study highlighted the potential influence of deep learning on the precision and effectiveness of the diagnosis of cardiomegaly, resulting in better patient outcomes.

In the paper "Cardiomegaly Detection using Deep Convolutional Neural Network with U-Net" by Sarpotdar, S. S., 2022, the authors used U-Net deep learning architecture to detect cardiomegaly from chest X-rays. The author found high accuracy and sensitivity results and came to the conclusion that the U-Net design has the potential to increase the accuracy and efficiency of the diagnostic procedure for cardiomegaly, resulting in better patient outcomes.

In the paper "Cardiomegaly Detection on Chest Radiographs: Segmentation Versus Classification" by Sogancioglu, E., 2020, the authors evaluated the performance of two different deep learning approaches for the detection of cardiomegaly from chest X-rays: segmentation and classification. The results were thoroughly examined by the authors, who discovered that segmentation performed better than classification in terms of sensitivity and accuracy but required more computational power. The results offer insightful information on how well different approaches for identifying cardiomegaly perform.

1.4 Project Timeline

- 5/Feb/2023 - Topic Identification
- 19/Feb/2023 - Dataset Finding and Collection
- 26/Feb/2023 - Machine Learning Model Identification and pre-processing Dataset
- 5/March/2023 - Training Machine Learning Models
- 19/March/2023 - Building and Training Custom/Hybrid CNN model
- 26/March/2023 - Miscellaneous work
- 29/March/2023 - Evaluation and Final Report

2. Project Goal

The objectives of Cardiomegaly Detection are:

- Detect cardiomegaly with accuracy using non-invasive techniques like imaging or other types of scanning.

- Results that are dependable and trustworthy can help healthcare practitioners make wise treatment choices.
- By enabling earlier detection and treatment of cardiomegaly, patients' outcomes will be improved.
- Increasing patient access to care is important, especially where it is scarce.
- Reduce the expenditures of healthcare related to late-stage or incorrectly diagnosed cases of cardiomegaly.
- Get the product regulatory permission so it can be utilized widely in a clinical environment.
- Encourage healthcare professionals and patients to accept the product by highlighting its benefits and efficiency.
- Offering a more simplified and trustworthy technique for detecting cardiomegaly, increasing clinical workflow and effectiveness.

2.1 Expected Results from the Project

- Accurate Case Detection: The product should be capable of detecting cases of cardiomegaly accurately, delivering trustworthy and dependable findings.
- Improved Patient Outcomes: Using the device to detect cardiomegaly early can result in earlier treatment and better patient outcomes.
- Increased Access to Care: The product ought to make it simpler for patients to get a diagnosis of cardiomegaly, especially in regions with restricted access to care.
- Healthcare Costs Will Be Lower: Cardiomegaly can be treated and detected early, which will cut down on later-stage or incorrectly-diagnosed cases' medical expenses.
- Regulatory Approval: The product ought to get regulatory approval, enabling extensive clinical use.
- User Adoption: To prove the product's worth and efficacy, it should be widely used by patients and healthcare professionals.
- Improved Clinical Workflow: By offering a more efficient and reliable technique for detecting cardiomegaly, the device should increase clinical workflow and efficiency.

2.2 Development Constraints

- Accuracy: The device must be able to identify cardiomegaly with great accuracy because a misdiagnosis could have negative effects on the patient.
- Accessibility: The product must be inexpensive for a wide range of patients and available to patients in a variety of geographic places.
- Regulatory Approval: In order to guarantee the product's safety and effectiveness for usage in a clinical environment, regulatory organisations like the FDA or CE must provide their approval.
- Data Privacy: In accordance with applicable data privacy laws and regulations, patient medical information must be kept private and safe.
- Clinical Validation: To show the product's efficacy and dependability, clinical trials must be conducted.
- Technical Suitability: The product must be technically sound and able to work with current medical technology and infrastructure.
- Cost-effectiveness: The product must be affordable because this will have a major impact on how widely it is used and how successful it is commercially.

3. Project Team

Name	Responsibility	Availability	Comments
Swastik Bagga	Topic Identification, Dataset Finding and Collection, Machine Learning Model identification and literature review, Training Machine Learning Models, Building Custom/Hybrid CNN model, Evaluation and Final Report	8 hours/week	
Sumukh Mydur	Topic Identification, Dataset Finding and Collection, Machine	8 hours/week	

	Learning Model identification and literature review, Training Machine Learning Models, Building Custom/Hybrid CNN model, Evaluation and Final Report		
Aathik Thayyil Radhakrishnan	Topic Identification, Dataset Finding and Collection, Machine Learning Model identification and literature review, Training Machine Learning Models, Building Custom/Hybrid CNN model, Evaluation and Final Report	8 hours/week	

4. Schedule and Milestone

Milestone	Description	Milestone Criteria	Planned Date
Topic Identification	Identification of Topic	Identification of Topic	5-Feb-2023
Dataset Finding and Collection	Finding all the data and forming dataset	Dataset is built	19-Feb-2023
Machine Learning Model Identification and literature review and pre-processing Dataset for model Training	Identifying Machine Learning models by doing literature review. Pre-processing of dataset for model training.	Models are identified and dataset is ready to be used for model training	26-Feb-2023

Training Machine Learning Models	Training machine learning models	Existing modern architecture models are trained	5-March-2023
Building and Training Custom/Hybrid CNN model	Building and Training Custom/Hybrid CNN model	Custom CNN model is built and trained.	19-March-2023
Miscellaneous work	Miscellaneous work	Miscellaneous work	26-March-2023
Evaluation and Final Report	Evaluation and Final Report	Evaluation and Final Report	29-March-2023

5. Communication and Reporting

The objectives of Communication and Reporting:

- To improve collaboration with the team and stakeholders
- To reduce errors and increase efficiency.
- Enables to save time and increases productivity.
- Helps in creating flexibility and business continuity.
- Enables resolving conflict.
- Understand data in detail.
- Organise and format the details about the data.
- To meet the stakeholder requirements.
- Acts as a guide on complex projects and identifies the key areas lacking in skill.
- To minimize confusion.

5.1 Frequency of Communication

The team will organize Team meetings once a week. The duration of the meeting lasts for at least 30 minutes. All the team members will be attending the meeting to discuss the work done that week.

5.2 Way the information is exchanged

5.2.1 Standup meetings

The objective of the meeting is to evaluate the progress and sync up with the work of team members so that all the team members are on the same page to avoid any conflicts.

5.2.2 Planning Meetings

The planning meeting is held before the start of each sprint. The main objective is to identify the amount of work that can be completed and delivered in that specific sprint and how it can be made possible. The meeting also includes a discussion regarding the work plan for the next successive sprint. Furthermore, priority is to be given to each task.

5.2.3 Retrospective Meetings

The sprint retrospective meeting is conducted at the end of each sprint. The meeting involves a review of the work demonstrated and the customer feedback is noted. The tasks done concerning the product backlog and artifacts produced are showcased during the sprint.

5.2.4 Knowledge Transfer Meetings

The team conducts a knowledge transfer session to share skills and analysis with the team once a week to ensure everyone is familiar with the new technology.

5.3 Process of Communication

5.3.1 Minutes of Meeting

A summary of what happened during the meeting, which will serve as an outline and a written record for anyone to use for future reference.

5.3.2 Microsoft Teams for Meeting

Meetings are done through Microsoft Teams so all the team members can join virtually. Team recordings are done for documentation.`

5.3.3 Microsoft Outlook to contact stakeholders

Regular Contact through emails is done to keep the stakeholder updated regarding the process of the project.

6. Delivery Plan

6.1 List of Deliverables:

6.1.1 Prototype or Demo:

A working prototype or demo of the cardiomegaly detection system to demonstrate its functionality and performance.

6.1.2 Software Code:

The source code and documentation for the cardiomegaly detection system, including the algorithms, models, and data pipelines.

6.1.3 Dataset:

The dataset used to train the cardiomegaly detection system, including the imaging data, annotations, and metadata.

6.1.4 Presentation:

Presentation of the Project with PowerPoint presentation to discuss briefly the Models used and comparative analysis with the results.

6.1.5 Final Report:

A report summarising the project's outcomes, including the system's development process, evaluation findings, and lessons learned.

6.2 List of Receivers

6.2.1 End users

The people who will utilise the comparative analysis system are known as end-users, and they include radiologists, cardiologists, and other healthcare professionals.

6.2.2 Customers

The businesses that will buy and use the comparative analysis system are known as customers. Examples of these businesses include hospitals, medical imaging centres, research institutions, government health agencies, and insurance firms.

6.2.3 Stakeholder

Stakeholders include people and entities like investors, government bodies, and trade organisations that have an interest in the project's success.

The Planned Delivery Date is 29th March 2023.

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