DEEP LEARNING FOR DETERMINING SKELETAL AGE

SOFTWARE REQUIREMENT SPECIFICATION

Submitted By:

ABHAY SHASTRY - ENG18CS0008

ANTONIO MERVYN - ENG18CS0056

BINISH RIZVI - ENG18CS0060

VARUN MENON - ENG18CS0314

of

BACHELOR OF TECHNOLOGY

in

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

at

DAYANANDA SAGAR UNIVERSITY

BANGALORE-560068

GUIDED BY: **Dr. Sanjay Chetnis and Prof. Swetha G S**

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1. INTRODUCTION

A Skeletal bone age assessment is a procedure used in pediatric radiology for both diagnostic and therapeutic investigations of endocrinology problems, children growth and genetic disorders. It is usually performed by radiological examination of the left hand, because of the discriminant nature of bone ossification stages of the non-dominant hand, and then compared to chronological age: a discrepancy between the two values indicates abnormalities. As we know, deep learning has been applied to computer vision tasks and achieved drastic performance improvement. We propose a method which learns real latent features of hand X-ray images and facilitates the feature capture to perform BAA. At the beginning of the method, we train the U-Net neural networks to precisely segment hand images from radiographs and eliminate insignificant information in raw X-ray images with an active learning technique. Then, we use pre trained deep Convolutional Neural Networks (CNNs) to extract high-level features with a transfer learning technique. After that, ensemble learning is employed to perform BAA with different base regressors. Finally, we evaluate the overall performance of our approach across different models.

1.1 Purpose

- To evaluate the accuracy and efficiency of a new automatic software system for bone age assessment and to validate its feasibility in clinical practice.
- To compare the performance of a deep-learning bone age assessment model based on hand radiographs with that of expert radiologists and that of existing automated models.

1.2 Intended Audience

Pediatric Professionals and medical institutions are the prime audience for this project.

1.3 Intended Use

This project is intended to be used in the medical field, especially in pediatrics. Traditionally, the skeletal age of a child is determined simply by comparing the X-ray of a patient to a huge sample set of X-rays corresponding to different skeletal ages and bone deformations/disorders. Therefore, the skeletal age of a patient is eventually determined by physical observation.

This is a tedious process that requires focus,accuracy and speed, making it a perfect application of deep learning. Hence, making it more efficient to calculate the bone age of a child.

1.4 Scope

The study proposes deep learning techniques to check skeletal bone age and also to generalize the gender and. This bone age assessment technique works on a public data set for all age ranges and genders. . The use of this assessment can be useful in identifying children with endocrine disruptors and growth disorders since the age of the bone and the actual age of the child, these differences can be indicative of skeletal growth abnormalities.

2. Overall Description

Patient skeletal age estimation using a skeletal bone age assessment method is a time consuming and very boring process. Today, in order to overcome these deficiencies, computerized techniques are used to replace hand-held techniques in the medical industry, to the extent that this results in better evaluation. The purpose of this research is to minimize the problems of the division of existing systems with deep learning algorithms and the high accuracy of diagnosis. The evaluation of skeletal bone age is the most clinical application for the study of endocrinology, genetic disorders and growth in young people. This assessment is usually performed using the radiologic analysis of the left wrist using the GP (Greulich-Pyle) technique or the TW(Tanner-Whitehouse) technique. Both techniques have many disadvantages, including a lack of human deductions from observations as well as being time-consuming

2.1 User Needs

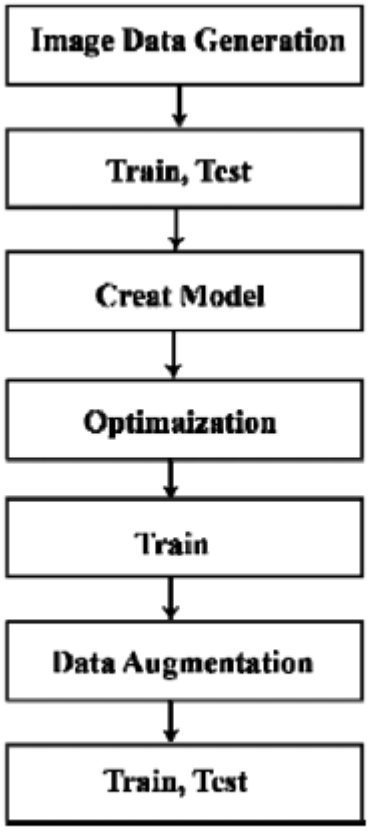
This application provides a simple way of determining skeletal age of a child. All the user has to do is upload an X- ray of the patient's left hand of acceptable resolution. The application then calculates the skeletal age in a relatively short amount of time and provides an accurate result.

2.2 Assumptions and dependencies

Our assumptions are primarily based on the Tanner Whitehouse(TW) technique for skeletal age assessment. In this method, each of the bones that is being evaluated is compared to a standard set of bones at different stages of maturation. A score is assigned to each bone based on maturation and sex of the patient.Once all the bones have been scored, a total score is generated by adding all bone scores together and then plotted on a graph to determine how the bone age relates to the chronological age.

3. System Features and Requirements

CNN layer has been trained from the beginning in a scanned X-ray data set. Network optimization allows the network to learn specific filters for black and white images as well as reduce the number of layers rather than adopting more general features.



3.1 Functional Requirements

In this research, as a convolutional network, the following modules are used respectively: a previously traced Convolution layer is considered as a black and white version. Also, CNNs are mostly used in classifying work; Bone Age Evaluation is a regression study. In this study, both the performance and the regression and classification method were evaluated to evaluate the best method. Both models have similar structure and protocols, and they differ only in the last two layers. This model contains a convolutional network with regression output.

3.2.1 Hardware Requirements/Interface

Core i7-4790 or Ryzen 3 3200G.
RTX 2080 Super, RTX 3070 (or RX 6800)
16GB RAM.
8GB VRAM.
50GB SSD storage.

3.2.2 Software Requirements/Interface

Windows 10 64-bit.
Python
Anaconda, Jupyter Notebook (or) WebBrowser for Google Colab.
In this system, there will be five libraries: KERAS, TENSORFLOW, PYPLOT in MATPLOTLIB, SIGMOID function from NUMPY and MATLAB.

3.3 System Features

- This project plans to improve the BA prediction accuracy to the level of professional radiology doctors.
- These techniques provide innovations in the design of deep neural networks by enabling deeper networks with a smaller number of weights, thus leading to higher classification accuracies while avoiding the overfitting problem.
- The evaluation of skeletal bone age is the most clinical application for the study of endocrinology, genetic disorders and growth in young people.
- This project examines the use of deep learning for medical imagery, especially for the evaluation of auto bone age using X-ray images.

3.4 Non functional requirements

Reliability : Reliability is one of the most important non functional requirements. Since this project is going to be used in the medical field, it is crucial that the application does not crash or perform poorly. In order to combat this, we have given the deep learning model a plethora of sample datasets to ensure there is no discrepancy in the application.

Speed : Speed is one of the major factors for the creation of this project, as this application is supposed to reduce time in calculating skeletal age. In order to achieve this the model is trained with plenty of datasets on a relatively powerful GPU to ensure fast and smooth operation

Accuracy: Accuracy is the other major factor next to speed which led to the creation of this project. To ensure accuracy, regions of interest of the X ray of the left hand are

marked and then classified into sub categories based on these regions of interest. The input X ray is then given a score that will help the model classify it into the categories previously created. This ensures proper accuracy of the result obtained.

Availability: Since this project is GPU intensive, it's availability is on a first come, first serve basis i.e the first X ray input will be analyzed first. This is due to the fact that only one X ray can be analyzed at a time.

Maintainability : All the functions and features in this project are implemented in the form of small modules. Therefore, additional modules can easily be added to this if new features are to be implemented. If any changes are to be made to existing modules, these changes will not affect the other modules

ABSTRACT

Bone Age is a metric that is used to calculate the maturity of bones in a patient.This tells us if the patient has any growth deficiencies or disorders. The evaluation of skeletal bone age is the most clinical application for the study of endocrinology, genetic disorders and growth in young people. This assessment is usually performed using the radiologic analysis of the left wrist using the GP (Greulich-Pyle) technique or the TW(Tanner-Whitehouse) technique. Both techniques have many disadvantages, including a lack of human deductions from observations as well as being time-consuming.

Today, in order to overcome these deficiencies,we have come up with a computerized technique to replace hand-held techniques, to the extent that this results in better evaluation.We have used deep learning techniques to minimize the problems of the division of existing systems.

The Deep Learning architecture we have used is Xception which is a modified CNN. CNNs are most commonly applied to analyse visual images and therefore a commonly used method in the medical field but have disadvantages in the form of the convolution operation being computationally expensive. Therefore we have used Xception to combat this.

The methods we have used might not only spare the human resources but also will reduce the costs spent on all the social and healthcare aspects of this procedure. Improved detection would also positively impact treatment trial design and accelerate the clinical development of novel
treatments for bone age deficiencies.

This project provides a simple way of determining the skeletal age of a child. All the user has to do is upload an X- ray of the patient's left hand of acceptable resolution. The application then calculates the skeletal age in a relatively short amount of time and provides an accurate result.