

# Advanced Gender Detection Using Deep Learning Algorithms Through Hand X-Ray Images

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**Abstract**— Identifying the gender, race, age, and stature of the target during the forensic inquiry is a critical stage in various events such as accidents, bombings, terrorism, wars, and disasters. In this paper, an application has been developed that uses hand X-rays to identify and determine gender for medical applications such as special cases where diagnosing the gender is difficult, like accidents in which the hand is amputated and unknown, severe burns, and in old skeletal structures using deep learning models. For comparative purposes, GoogLeNet and ResNet-18 were employed. Gender determination using hand X-rays yielded positive results. The accuracy of gender detection in the model GoogLeNet (validation, training, test, and total) is (76.67%, 96.68%, 53.33%, and 89.5%) respectively, while the accuracy of gender detection in the model ResNet-18 (validation, training, test, and total) are (80%, 99.29%, 87.5%, 94.63%) respectively. The ResNet-18 model was adopted as the best model for gender detection and determination because high results were obtained. Simulation results showed acceptable results with high accuracy in diagnosis, where the highest gender determination rate was obtained through hand X-ray analysis at 94.63%.

**Keywords**— *Deep Learning, Hand X-rays, GoogLeNet, ResNet-18, Gender detection, convolutional neural network (CNN).*

## I. INTRODUCTION

In the analysis of forensics, the gender classification of the individual is the foundation. It is an essential part of each stimulating task and medico-legal inspection for forensic experts [1]. In different positions such as accidents, shelling, terrorism, war, and disasters, the main step is to identify the age, gender, ethnicity, and status of the target during forensic investigations. To identify human remains, it is possible to rely on hand dimensions in gender rating [2]. Where it is considered a smart and favorite part of the human body. This step is one of the most important steps that help forensic experts.

Deep learning is of great importance in helping forensic experts, and many research works in this area [3-17]. CNN is a sort of neural network that is frequently used in image analysis. It is made up of one or more convolutional layers. CNN requires training to categorize objects by converting characteristics and images from an input image. A system uses

the input image as a tester during the analysis. Feature extraction was the result of the investigation. The contrast between pixel portions of input is referred to as features. CNN achieves the best level of accuracy in this manner [18], [19].

In [3], deep learning models were used to detect the gender of the individual as well as know the age through hand radiation images, where VGG-16 was used for this purpose. According to the paper provided, good results were obtained.

In [20], The Deep Convolutional Neural Network (DCNN) models are VGG-16 and ResNet50 has been used with ImageNet pre-trained weights to estimate correct bone age and ensure improved gender prediction accuracy using the public RSNA dataset. During the gender categorization procedure, the testing results show an eight-month monthly disparity and 82 percent accuracy.

In [21], using frontal chest X-ray pictures, a method for automatically detecting the gender of an imaged person was given. To solve the difficulty of producing handmade features with limited data, the suggested method uses a convolutional neural network (CNN) based deep learning and transfer learning. Pre-processing, CNN feature extractor, feature selection, and classifier are the four basic phases of the approach. AlexNet, VggNet, GoogLeNet, and ResNet were the four CNN architectures that were examined and compared in this approach. With an accuracy of 86.6 %, the VggNet-16 feature extractor with the SVM classifier is the top performance. In [22], compiled a dataset of 8,325 radiographs of the hand and wrist from a cohort of pediatric patients, ranging from 5 years to 18 years of age. 6,268 (3,222 females and 3046 males) radiographs were used for training, and 821 images (421 females and 400 males) separate from the training data were randomly selected for validation. Following a series of preprocessing steps, images were analyzed using a deep CNN. Of the 1,236 radiographs tested, the algorithm predicted gender with 91.1% accuracy (89.8% in females and 92.5% in males).

In this paper, individual gender has been detected from a model through an independent application that contains a ResNet-18 model. As shown in Fig. 1, hand radiation images are passed to histogram equalization (HE) and Contrast-limited adaptive histogram equalization (CLAHE), then the size and dimension of images are changed to pass to the