A PROJECT REPORT

on

"BONE FRACTURE RECOGNITION USING YOLOv5 MODEL"

Submitted to

KIIT Deemed to be University

In Partial Fulfilment of the Requirement for the Award of

BACHELOR'S DEGREE IN

INFORMATION TECHNOLOGY

BY

AYANAVA CHAKRABORTY	2105023
RANJANA SAHA	2105053
RAUL DAS	2105224
SOUMYADEEP SAHA	2105246
SAGNIK GHOSH	21052699

UNDER THE GUIDANCE OF

Dr. SAMPRITI SOOR

SCHOOL OF COMPUTER ENGINEERING

KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY

BHUBANESWAR, ODISHA - 751024

APRIL 2024

KIIT Deemed to be University

School of Computer Engineering
Bhubaneswar, ODISHA 751024

CERTIFICATE

This is certify that the project entitled

"BONE FRACTURE DETECTION USINGYOLOv5 MODEL "

submitted by

AYANAVA CHAKRABORTY	2105023
RANJANA SAHA	2105053
RAUL DAS	2105224
SOUMYADEEP SAHA	2105246
SAGNIK GHOSH	21052699

is a record of bonafide work carried out by them, in the partial fulfilment of the requirement for the award of Degree of Bachelor of Engineering (Computer Science & Engineering OR Information Technology) at KIIT Deemed to be university, Bhubaneswar. This work is done during year 2022-2023, under our guidance.

Date: / /

Dr. Sampriti Soor
Project Guide

Acknowledgements

We are profoundly grateful to **MR. SAMPRITI SOOR** of **Affiliation** for his expert guidance and continuous encouragement throughout to see that this project rights its target since its commencement to its completion. ....

AYANAVA CHAKRABORTY
RANJANA SAHA
RAUL DAS
SOUMYADEEP SAHA
SAGNIK GHOSH

ABSTRACT

This report presents a comprehensive study on bone fracture recognition using Python programming in Thonny IDE and Tensor Flow based on the YOLOv5 model. The research focuses on developing an efficient and accurate system for automating the detection and classification of bone fractures from medical images. The YOLOv5 model, known for its speed and accuracy in object detection tasks, is utilized to enhance the recognition of fractures in X-ray images.

The report details the methodology of training the YOLOv5 model on a data set of bone fracture images, optimizing the model for improved performance, and evaluating its effectiveness in accurately identifying different types of fractures. Various technical aspects, including data pre processing, model training, hyper parameter tuning, and model evaluation metrics, are discussed to provide insights into the development process.

Results from the experimentation showcase the model's capability to detect and classify bone fractures with high precision and recall rates. The report also discusses the practical implications of deploying such a system in a clinical setting, highlighting its potential to assist health care professionals in diagnosing fractures more efficiently and accurately.

Overall, this report contributes to the advancement of medical imaging technology by demonstrating the feasibility and effectiveness of using deep learning models like YOLOv5 for bone fracture recognition, paving the way for enhanced diagnostic tools in the field of orthopedics.

Contents

Chapter 1

Introduction

Early and accurate bone fracture detection is crucial for timely treatment and positive patient outcomes. Traditional methods like X-rays and CT scans often require human expertise, which can be subjective and time-consuming. Deep learning techniques like YOLOv5 offer promise for automated fracture detection, potentially improving efficiency and accuracy. This project aims to address these limitations by developing a computer-aided system using YOLOv5 in Python for automated bone fracture detection in X-ray images.

This project aims to develop a computer-aided system using YOLOv5 in Python to automatically detect bone fractures in X-ray images. The system will leverage the power of deep learning for image recognition and object detection, specifically identifying and localizing fractures in X-ray data

We'll build a system using YOLOv5, a powerful deep learning model for object detection. The project involves:

Ethical Data Collection: Gathering X-ray images showcasing diverse fractures, prioritizing ethical practices.

Data Preprocessing: Preparing the images by resizing, adjusting, and potentially expanding them to enhance training.

YOLOv5 Model Selection: We'll either leverage a pre-trained YOLOv5 model fine-tuned for fracture detection or train a custom model from scratch (depending on the dataset complexity).

Python Code Development: Writing Python code using OpenCV and NumPy to handle image processing, model interaction, and result visualization.

Deployment: Deploying the system locally for research or creating a secure web application for potential clinical use.

This project demonstrates the potential of deep learning to assist medical professionals in achieving faster and potentially more accurate bone fracture detection. It's important to remember that this is for educational purposes only and shouldn't replace a doctor's evaluation.

Chapter 2

Basic Concepts

The basic concept of our project involves using the YOLOv5 model for bone fracture detection. YOLOv5 is a deep learning model that excels in object detection tasks, and in this case, it will be trained to detect fractures in bone images or scans. The model will be trained on a dataset of bone images with and without fractures, learning to accurately identify and localize fractures within the images. Once trained, the model can be deployed to automatically detect fractures in new images or scans, aiding in medical diagnosis and treatment planning.

Bone Fracture Detection Techniques:

Conventional Methods:
X-rays: The most common imaging modality for bone fractures, providing a relatively inexpensive and readily available option. However, X-ray interpretation requires trained radiologists, and image quality can affect accuracy.

CT Scans:

Offer detailed cross-sectional images for complex fractures, but are more expensive and involve radiation exposure.

Deep Learning for Bone Fracture Detection:

Deep learning models, especially convolutional neural networks (CNNs), have demonstrated remarkable capabilities in image recognition and object detection tasks.

YOLOv5 (You Only Look Once, version 5) is a state-of-the-art object detection model known for its speed and accuracy, making it a suitable candidate for this project.

Existing research has explored deep learning for bone fracture detection with promising results. However, challenges remain, such as the need for large, high-quality datasets and ensuring generalizability to diverse patient populations.

YOLO Model Evolution overtime:

YOLOv1 (2015):

Focus: Introduced the core YOLO concept - a single neural network predicting bounding boxes and class probabilities directly from full images. This offered real-time object detection capabilities compared to slower methods of the time.
Limitations: Accuracy was lower compared to some existing models. It also relied on hand-crafted features, limiting flexibility.

YOLOv2 (2016):

Improvements: Introduced "anchor boxes" for improved bounding box prediction accuracy. Incorporated a "passthrough layer" to allow for better localization of smaller objects.
Outcome: Achieved a better balance between speed and accuracy than YOLOv1.

YOLOv3 (2018):

Advancements: Introduced a multi-scale feature extraction architecture, allowing for detection of objects at various scales within an image. Incorporated a residual network (ResNet) backbone for enhanced feature extraction capabilities.
Benefits: Achieved significant improvements in both accuracy and speed compared to YOLOv1 and YOLOv2.

YOLOv4 (2020):

Focus: Emphasized model flexibility and ease of deployment. Introduced various model variations (e.g., YOLOv4-tiny, YOLOv4-CSPDarknet53) catering to different speed and accuracy needs.
Key Features: Introduced techniques like CSPDarknet (Cross Stage Partial connections) for improved model efficiency and Path Aggregation Network (PAN) for better feature fusion across different scales.

YOLOv5 (2020):

Focus: Streamlined model design, training efficiency, and user experience. Introduced a focus module for better small object detection and various data augmentation techniques for robust training.
Highlights: Considered the easiest to use YOLO version yet, offering good accuracy while maintaining real-time processing speeds. Built on top of PyTorch, a popular deep learning framework.

Overall Trajectory:

The YOLO series has consistently strived to achieve a balance between speed and accuracy in real-time object detection. Each iteration has introduced advancements in:

Model architecture: Utilizing more sophisticated network backbones and feature extraction techniques.
Object detection mechanisms: Refining bounding box prediction and localization methods.
Training efficiency: Incorporating data augmentation and other techniques to improve model robustness.
Usability: Making the models easier to train, deploy, and integrate into applications.
YOLOv5 stands as the current culmination of these efforts, offering a powerful and user-friendly deep learning model for object detection tasks.

Chapter 3

Data specifications and functional requirements

We have acquired the dataset from : https://roboflow.com/integration/yolov5

Problem Statement:

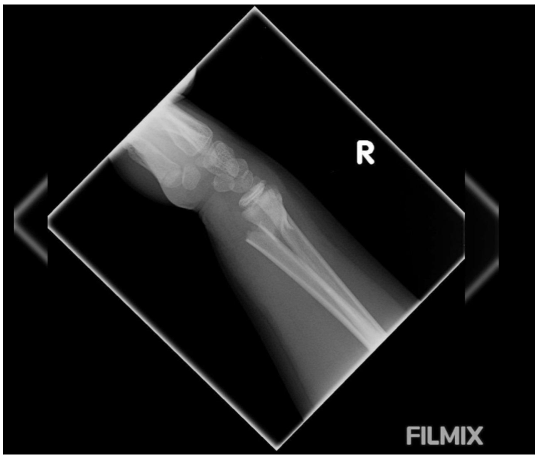
Develop a computer-aided system using YOLOv5 in Python for automated bone fracture detection in X-ray images.

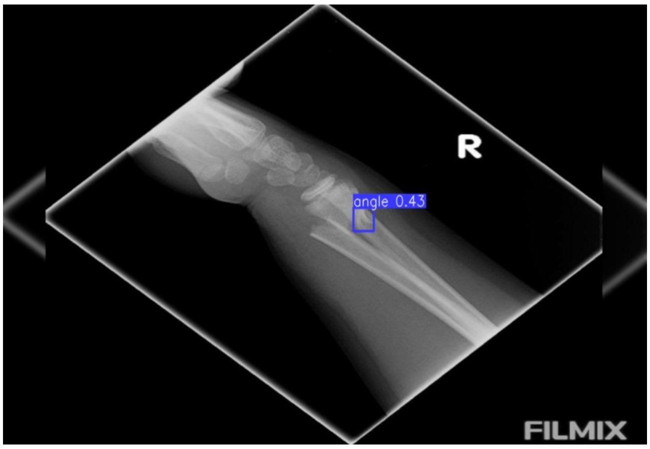
Functional Requirements:

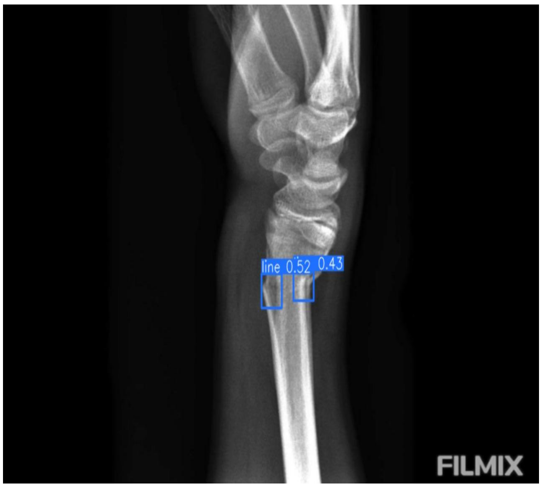
Input:
Format: Mp4 and JPEG
Resolution: 1020px X 600px
Output:
Format: Bounding boxes around detected fractures with corresponding class labels “Fracture”, “line”, “angle” and “messedup angle”.
Accuracy: From the model we have achieved 85% accuracy after the training and testing of data sets.

Non-Functional Requirements:

Performance:
Processing speed:
Using GPU T4 and 16 GB of RAM the total time required is 37 mins for 416 images i.e. 5.3s for each image
Scalability:
The system should be able to handle variations in image size and potentially handle multiple types of fractures in the future.







Timeline:

Data collection and preparation
YOLOv5 model selection/training
Python code development
Testing and evaluation

Resource Allocation:

Software: Gpu used with the help of google collaborator
Python (3.x recommended)
NumPy for numerical computations
OpenCV for image processing and computer vision tasks
YOLOv5 deep learning model

Risk Management:

Identify potential risks and mitigation strategies:

Risk: Limited data availability
Mitigation: Explore publicly available datasets or consider ethical data collection practices (consult medical personnel).
Risk: Model underfitting/overfitting
Mitigation: Techniques like data augmentation, regularization, and hyperparameter tuning can be employed.
Risk: Performance bottlenecks
Mitigation: Explore hardware optimization, model efficiency techniques.

SYSTEM DESIGN:

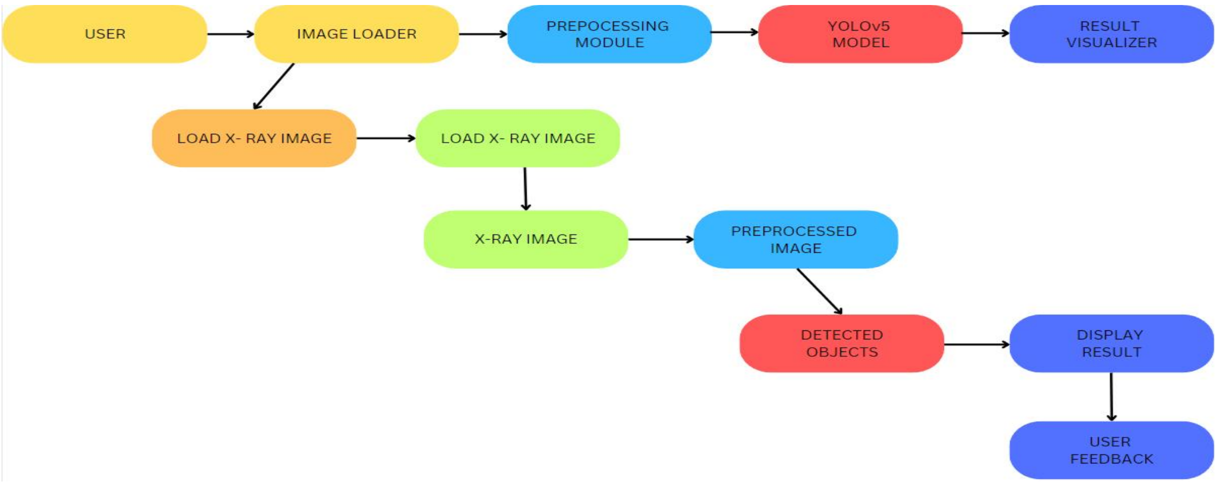
Process Flowchart

System Architecture Overview: X-ray Image Processing

Introduction:

The X-ray Image Processing system serves as a comprehensive solution for the analysis of X-ray images, employing a modular architecture to ensure efficient processing and accurate results. This document provides an extensive overview of the system architecture, detailing its various components, data flow, and interactions.

System Architecture Components:



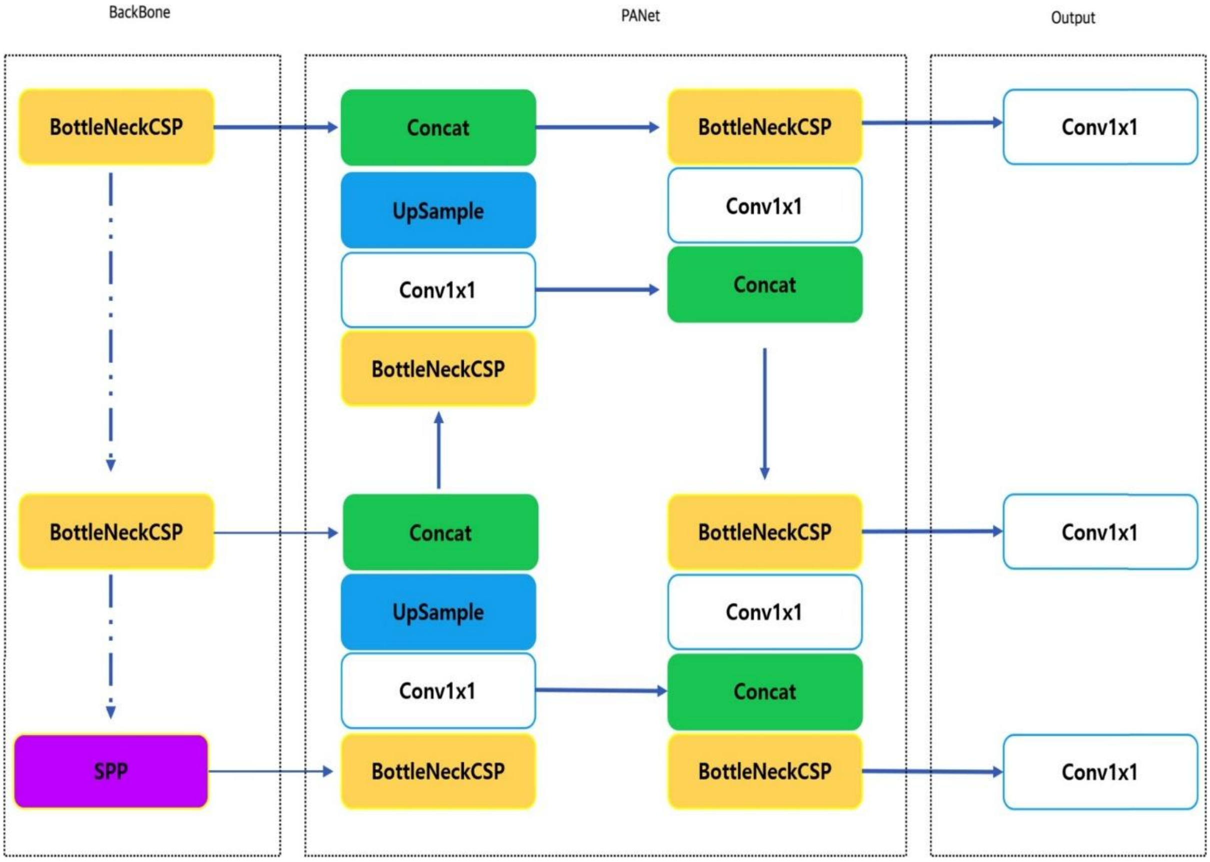
1. Interface (User/External):
- The Interface module serves as the primary point of interaction between users or external systems and the X-ray processing system. It facilitates user input and system output.

2. Image Loading Module:
- Responsible for the seamless loading of X-ray images into the system, the Image Loading Module ensures the acquisition of input data for subsequent processing stages.

3. Preprocessing Module:
- The Preprocessing Module undertakes essential preprocessing tasks on the loaded X-ray images, optimizing them for subsequent analysis. Tasks encompassed within this module include resizing, normalization, noise reduction, and contrast enhancement.

4. YOLOv5 Model (Object Detection):

- Central to the system's functionality, the YOLOv5 Model is tasked with performing object detection on preprocessed X-ray images. Leveraging state-of-the-art deep learning techniques, it identifies and localizes relevant objects within the images.



5. Result Processing & Visualization:

- Following object detection, the Result Processing & Visualization module processes the output generated by the YOLOv5 Model. This encompasses tasks such as filtering detections, calculating confidence scores, and preparing the results for visualization.

6. Display Module (UI/Output):

- The Display Module serves as the final interface between the system and the user or external entities. It presents the processed results in a comprehensible format, potentially utilizing graphical user interfaces (UIs) or other output mechanisms.

Data Flow:

The X-ray image processing system adheres to a structured data flow model, ensuring the seamless transition of information between its constituent modules:

- **User Action:** Commences the process by loading X-ray images into the system.

- **Image Loading Module:** Receives and processes user requests to load X-ray images, facilitating the acquisition of input data.

- **Preprocessing Module:** Applies a series of preprocessing steps to the loaded X-ray images, optimizing them for subsequent analysis.

- **YOLOv5 Model:** Executes object detection algorithms on preprocessed images, identifying and localizing relevant objects within the X-ray scans.

- **Result Processing & Visualization:** Processes the output of the YOLOv5 Model, refining and presenting the detected objects in an understandable format.

- **Display Module:** Presents the processed results to the user or external systems, facilitating interpretation and decision-making.

Chapter 4

Implementation

4.1 Proposal

Early and accurate bone fracture detection is crucial for timely treatment and improved patient outcomes. Traditional methods like X-rays require trained radiologists and can be time-consuming. This proposal outlines the development of a computer-aided system using YOLOv5, a deep learning model, to automate bone fracture detection in X-ray images.

4.2 Verification Plan

After implementation of the Yolov5 model on a series of X-ray images we concluded that it was showing the accurate points where the fractures were present, along with the side of the body where the bone belongs. We divided the data set into 2 parts i.e 25% for testing and rest 75% for training, where we achived our desired output. Screenshots of the outputs and inputs are given below.

4.3 Screenshots of the inputs and outputs

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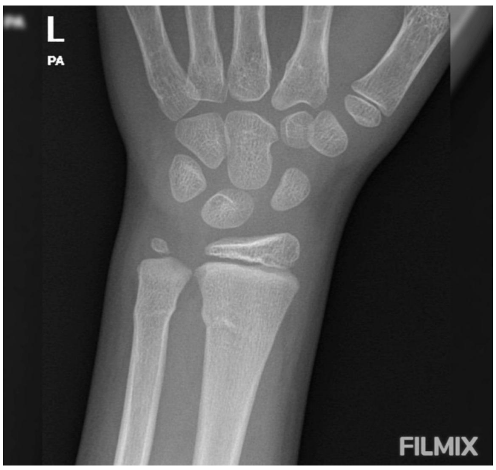
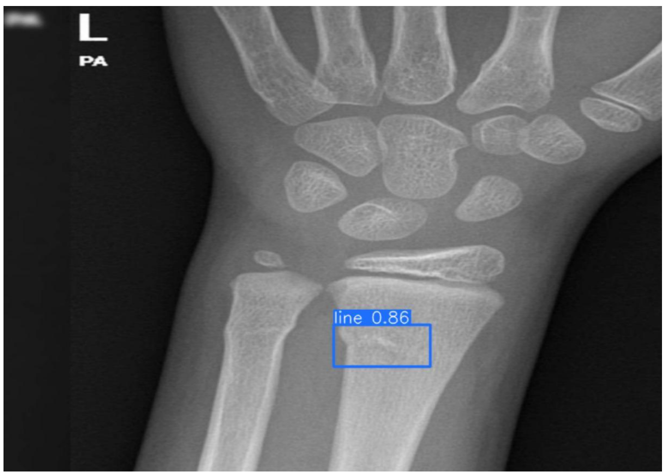
INPUT



OUTPUT



Chapter 5

Conclusion and Future Scope

5.1 Conclusion

This project explores the development of a computer-aided system using YOLOv5 in Python for automated bone fracture detection in X-ray images. Here's a quick overview:

Goal: To build a system that can automatically identify fractures in X-ray images.

Methodology:

Gather X-ray data (ethical considerations are paramount).
Preprocess images for training.
Select or train a YOLOv5 model for fracture detection.
Develop Python code for image processing, model inference, and result visualization.
Evaluation:
Test the system using various approaches (unit, integration, system testing).
Analyze accuracy, processing speed, and visualize results for understanding.

5.2 Future Scope

This project serves as a foundation for further exploration of bone fracture detection using deep learning. Here are some potential areas for future development:

Expanding Dataset: Incorporate a larger and more diverse dataset of X-ray images encompassing various fracture types and bone structures.

Model Refinement: Fine-tune the YOLOv5 model or explore other deep learning architectures potentially suited for fracture detection.

Multiple Fracture Detection: Enhance the system's ability to detect multiple fractures in a single image.

Localization Refinement: Improve the accuracy of fracture localization within the image, providing more precise bounding boxes.

Clinical Integration: Explore potential integration with medical imaging software, allowing doctors to leverage the system's output for enhanced diagnosis.

Explainability (XAI): Incorporate explainable AI (XAI) techniques to understand the model's reasoning behind detections, improving trust and interpretability.

Generalization and Validation: Conduct thorough clinical validation studies with medical professionals to assess the system's performance in real-world scenarios.

By building upon this project's foundation and exploring these future directions, we can contribute to the advancement of deep learning-based solutions for automated medical image analysis, potentially aiding in faster and more accurate bone fracture detection.

References

[1] https://github.com/sidpro-hash/Helmet-Detection-YOLOv5

[2] https://www.kaggle.com/

[3] https://en.wikipedia.org/wiki/Small_object_detection.

[4] YOLOv5 : A Revolutionary Leap in AI by Henri Van Maarseveen

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INDIVIDUAL CONTRIBUTION REPORT:

BONE FRACTURE RECOGNITION USING YOLOv5 MODEL

RAUL DAS
210224

Abstract: This abstract highlights my individual contribution to the development of a computer-aided system for automated bone fracture detection in X-ray images. The system leverages the power of YOLOv5, a deep learning object detection model, implemented within a Python framework.

Individual contribution and findings: During the preparation of the project, I wrote the code for training the data sets and helped in the testing of the model made.

Individual contribution to project report preparation: Helped in providing the pictures from the data sets for the part of implementation

Full Signature of Supervisor: …………………………….

Full signature of the student: ……………………………..

INDIVIDUAL CONTRIBUTION REPORT:

BONE FRACTURE RECOGNITION USING YOLOv5 MODEL

AYANAVA CHAKRABORTY
2105023

Abstract: This abstract highlights my individual contribution to the development of a computer-aided system for automated bone fracture detection in X-ray images. The system leverages the power of YOLOv5, a deep learning object detection model, implemented within a Python framework.

Individual contribution and findings: .During the preparation of the project, I helped in coding for testing the data set and running the model to be worked upon.

Individual contribution to project report preparation: I contributed to the project report by arranging the materials required for the making of the report and helped in writing all the elements from scratch.

Full Signature of Supervisor:	Full signature of the student:
…………………………….	……………………………..

INDIVIDUAL CONTRIBUTION REPORT:

BONE FRACTURE RECOGNITION USING YOLOv5 MODEL

SAGNIK GHOSH
21052699

Abstract: This abstract highlights my individual contribution to the development of a computer-aided system for automated bone fracture detection in X-ray images. The system leverages the power of YOLOv5, a deep learning object detection model, implemented within a Python framework.

Individual contribution and findings: During the development of the project my primary contribution was mainly during preprocessing and coding for other data sets to base the model of the current project.

Individual contribution to project report preparation: I contributed to the project report by arranging the materials required for the making of the report and helped in writing all the elements from scratch.

Full Signature of Supervisor: ……………………………

Full signature of the student: ……………………………..

INDIVIDUAL CONTRIBUTION REPORT:

BONE FRACTURE RECOGNITION USING YOLOv5 MODEL

SOUMYADEEP SAHA
2105246

Abstract: This abstract highlights my individual contribution to the development of a computer-aided system for automated bone fracture detection in X-ray images. The system leverages the power of YOLOv5, a deep learning object detection model, implemented within a Python framework.

Individual contribution and findings: My contribution to the project was to find the datasets to train and helping in coding of the model.

Individual contribution to project report preparation: Provided the technical details required for thr project like accuracy, precision, time required etc.

Full Signature of Supervisor: ……………………………

Full signature of the student: ……………………………..

INDIVIDUAL CONTRIBUTION REPORT:

BONE FRACTURE RECOGNITION USING YOLOv5 MODEL

RANJANA SAHA
2105053

Abstract: This abstract highlights my individual contribution to the development of a computer-aided system for automated bone fracture detection in X-ray images. The system leverages the power of YOLOv5, a deep learning object detection model, implemented within a Python framework.

Individual contribution and findings: My contribution to this project was to help find the data sets and framing the images for training the model

Individual contribution to project report preparation: In report preparation I helped to make the UML block diagrams which show the system design.

Full Signature of Supervisor: ……………………………

Full signature of the student: ……………………………..

TURNITIN PLAGIARISM REPORT