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WELLWISE: ADVANCED NUTRITION MONITORING SYSTEM

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Abstract: In recent times, advancements in deep learning and computer vision have paved the way for innovative solutions in food detection and nutritional analysis. This paper presents a pioneering framework for detecting food items using ensemble learning techniques, leveraging cutting-edge object detection models like YOLOv7 and YOLOv8. The proposed system aims to precisely identify and categorize various food items in images, catering to diverse user needs such as nutrition research, dietary monitoring, and culinary exploration. The framework initiates by pre-processing food images and inputting them into multiple pre-trained YOLOv7 and YOLOv8 models to extract features and generate decision scores for each detected food item. These decision scores are then combined using a fusion technique, such as the Gompertz function, to amalgamate the strengths of each model and enhance prediction accuracy. To assess the system's performance, experiments are conducted using a comprehensive food image dataset encompassing a wide variety of cuisines and dishes. Performance metrics including accuracy, precision, recall, and F1-score are measured to evaluate the effectiveness of the ensemble approach in accurately detecting and categorizing food items. The proposed framework offers a sturdy and efficient solution for food detection tasks, serving diverse user classes including nutrition researchers, health-conscious individuals, restaurant owners, and culinary enthusiasts. By harnessing ensemble learning techniques and state-of-the-art object detection models, the system aims to empower users with precise and reliable food detection capabilities, facilitating applications such as dietary monitoring, nutrition analysis, and food recognition systems across various domains.

Keywords: YOLOv7 , YOLOv8, Ensemble learning, nutrition monitoring system.

I. INTRODUCTION

In today's fast-paced world, the daily consumption of high-calorie foods may appear innocuous but conceals a dangerous trap leading to conditions like diabetes, obesity, and hypertension. As our reliance on technology grows, individuals are turning to Food Tracker Apps to monitor their diet. However, the burden of manual data entry has emerged as a significant drawback, prompting many to abandon these apps over time. Our project proposes an innovative solution to this challenge. By leveraging advanced deep learning algorithms, sophisticated computer programs capable of learning and analysing, we aim to simplify the process. Users can now capture images of their meals, allowing the algorithms to recognize the food items and approximate their nutritional content. This approach eliminates the time-consuming manual entry, making it more convenient and encouraging users to maintain healthier eating habits. Acknowledging the common struggle to meet daily water intake goals, we have integrated an additional feature into our project. This feature tracks an individual's water consumption, serving as a supportive tool to remind users to achieve their recommended daily water intake. Our vision is to harness technology to improve well-being, ensuring that managing nutrition and hydration is not only effective but also easily manageable.

II. RELATED WORK

1. **IndianFoodNet: Detecting Indian Food Items Using Deep Learning(2023)** : Ritu Agarwal1* , Tanupriya Choudhury1,2,3 , Neelu J. Ahuja1 , Tanmay Sarkar4, School of Computer Science, University of Petroleum and Energy Studies (UPES), Dehradun 248007, India CSE Department, Graphic Era Deemed to be University, Dehradun 248002, Uttarakhand, India CSE Department, Symbiosis Institute of Technology, Symbiosis International (Deemed University), Pune 412115, India Department of Food Processing Technology, Malda Polytechnic, Bengal State Council of Technical Education, Malda 732102, India Corresponding Author Email: agarwalritu7@gmail.com.
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2. Food Recognition Using Deep Convolutional Neural Network (Jun 2020) : Food Recognition using Convolution Neural Network Proposal for a food recognition system using deep learning algorithms Uses Convolution Neural Network to detect a single food item in an image and predict its nutritional content Trained and optimized a CNN model using TensorFlow 2.0. Achieved mean accuracy of 85% in both normal and extended FOOD-101 dataset. Utilized Nutritionix API for nutritional values and Tkinter for GUI. Proposed model performs well in terms of speed and accuracy. Future integration with state-of-art models like YOLO for better results and accuracy.

3. **Food Recognition Using Deep Convolutional Neural Network (Jan 2022)** : Food monitoring and nutritional analysis assumes a main part in health-related issues; it is getting more essential in our everyday lives. In this paper, we apply a convolutional neural network (CNN) to the task of detecting and recognizing food pictures and to estimate nutrition in the food. Considering the wide variety of food, image recognition of food items is extremely troublesome. Food 101 dataset are used for train and test the model, we are using 101 different classes of food images in order to improve accuracy of model. The proposed model provides more than 80% of accuracy. The main objective of this is to recognize and detecting food.

III. DATASET PREPARATION

In this study, we have used the dataset Nutriscan-Final for food object detection. This dataset is a collection of food items. The dataset is been taken from Roboflow. The dataset has a total of 9736 food samples**.**

Fig 3.1 : Sample of valid images taken from Nutriscan-Final

IV. METHODOLOGY

The methodology proposed for food object detection involves the utilization of two models: YOLOV7 and YOLOV8. Initially, the image is captured from the application using the device's camera. Subsequently, the captured image is transmitted to a Node.js server for further processing. Within the Node.js environment, the image is then forwarded to a Python script responsible for conducting the image prediction tasks. This stage encompasses various image processing techniques aimed at accurately identifying objects within the image. Once the image processing is completed, the detected objects are classified, and their corresponding nutritional contents are extracted.

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Finally, the processed information, including the detected objects and their nutritional details, is relayed back to the mobile application, where it is displayed to the user. Through this iterative process, the methodology achieves efficient food object detection and provides users with valuable nutritional insights.

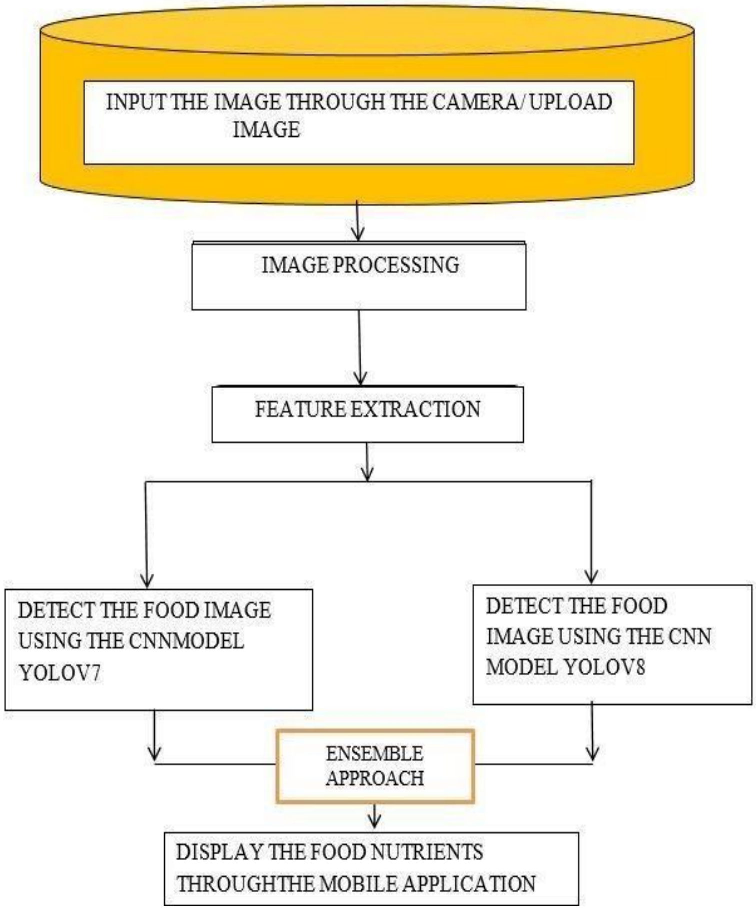

Fig 4.1: Architectural Diagram of Proposed System

4.1 Image Classification Model

YOLOv7 and YOLOv8 are state-of-the-art object detection models known for their efficiency and accuracy. They belong to the YOLO (You Only Look Once) family of models, which are designed for real-time object detection tasks. The basic building block of the YOLOv7 and YOLOv8 architectures is the YOLOv7 and YOLOv8 block, which includes a series of convolutional layers followed by a prediction layer. These blocks are stacked to create a deep neural network that can detect objects in images with high accuracy. YOLOv7 and YOLOv8 models incorporate various improvements over earlier versions, including enhanced feature extraction capabilities and improved prediction accuracy. They utilize advanced techniques such as feature pyramid networks (FPNs) and focal loss to effectively detect objects of different sizes and classes in complex scenes. YOLOv7 and YOLOv8 also incorporate efficient design principles to optimize computational resources and model size while maintaining high performance. This allows them to achieve real-time object detection on various platforms, including embedded systems and mobile devices.

For food item classification using YOLOv7 and YOLOv8 models, the following steps would be involved:

Data Preparation: Gather a diverse dataset of food item images for training, validation, and testing the model. Ensure that the dataset contains images of various

- **Data Pre-processing:** Resize the food item images to a consistent size and format that the YOLOv7 and YOLOv8 models expect as input. Additionally, label the images with bounding boxes around the food item to facilitate training.

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- **Model Training:** Split the pre-processed food item image dataset into training, validation, and test sets. Train the YOLOv7 and YOLOv8 models on the training set using techniques such as transfer learning to fine-tune the models for food item detection.

- **Model Evaluation:** After training, evaluate the performance of the trained YOLOv7 and YOLOv8 models on the validation and test sets. Measure metrics such as precision, recall, and mean average precision (mAP) to assess the models' accuracy and generalization ability.

- **Model Fine-tuning:** If the model's performance is not satisfactory, perform model fine-tuning by adjusting hyper parameters, optimizing training strategies, or incorporating additional training data to further improve accuracy

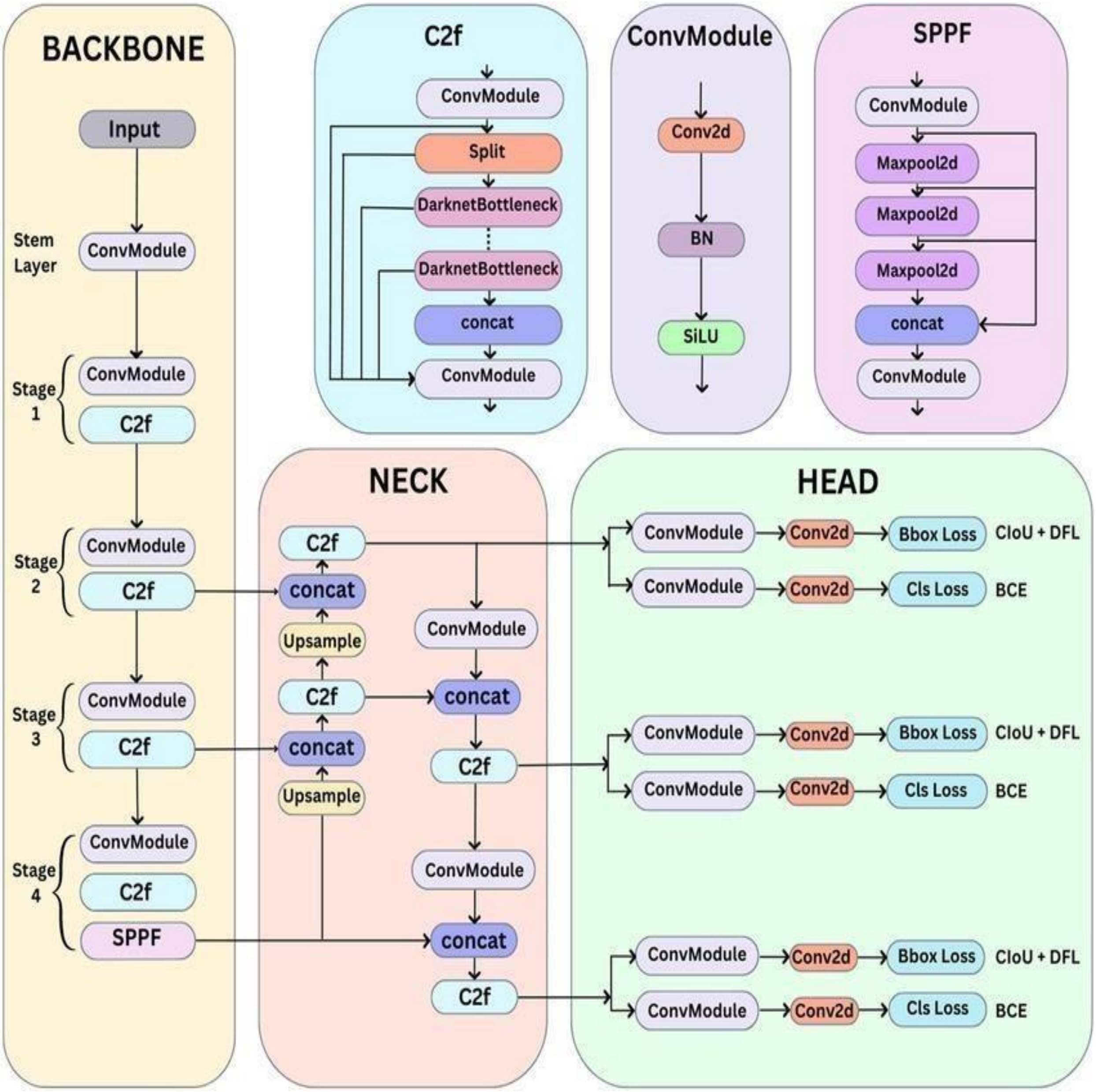

Fig 4.2: Block Diagram of YOLOv8

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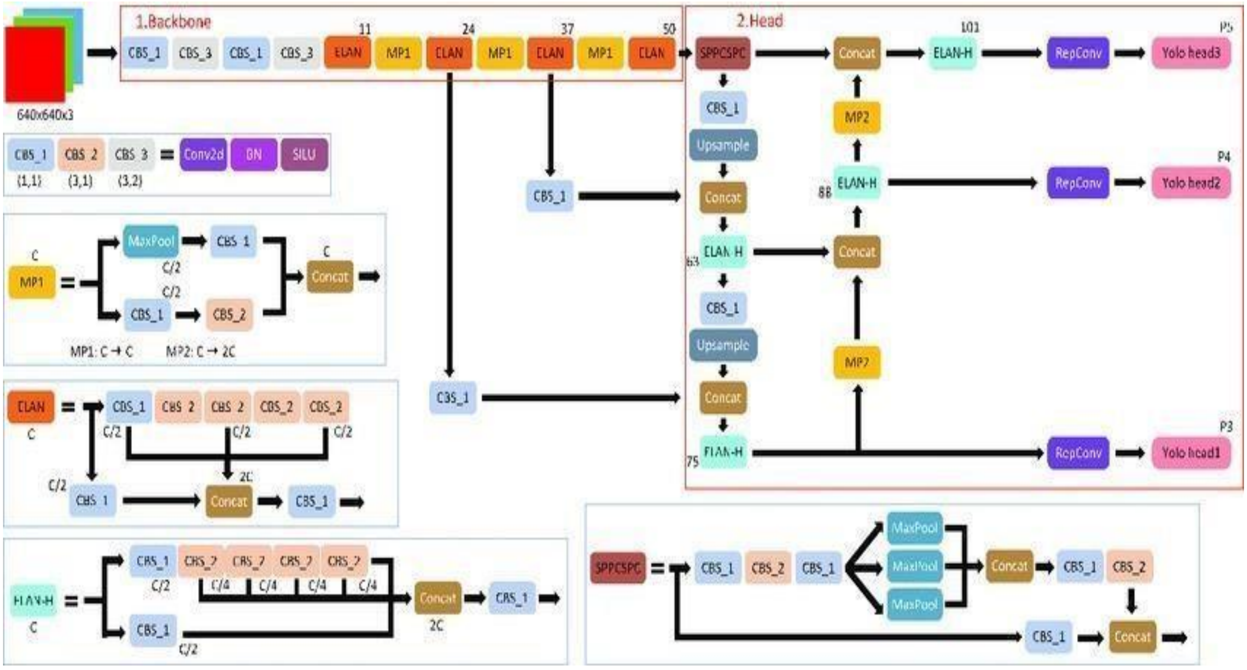

Fig 4.3: Block Diagram of YOLOv7

Overall, YOLOv7 and YOLOv8 models offer a powerful and efficient solution for food item classification tasks, leveraging advanced object detection techniques to accurately identify food item in images with high efficiency.

V. RESULTS

In this deep learning project, we trained two different models, namely YOLOv7 and YOLOv8 for the task of food classification using image. The training process involved using adataset of Food images implementing the respective architectures of each model.

The model for detecting food objects was able to achieve a very high accuracy of 94% of accuracy in both training and validation. The model YOLOV7 was specifically able to achieve 92% accuracy and the model YOLOV8 was able to achieve 97% accuracy. The nutrition details of the detected food items were given from pre-stored the database.

The models were trained with 25 epochs. The training results showed promising performance for all two models. The accuracy of each model was evaluated. The results showed in below:

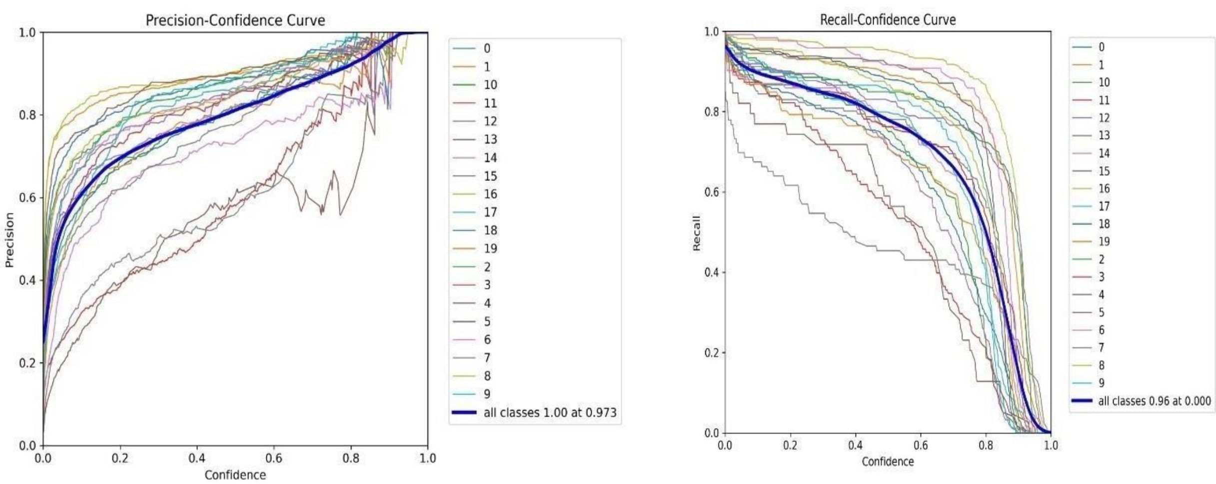

Fig 5.1 – YOLOv8 Model Accuracy and Loss

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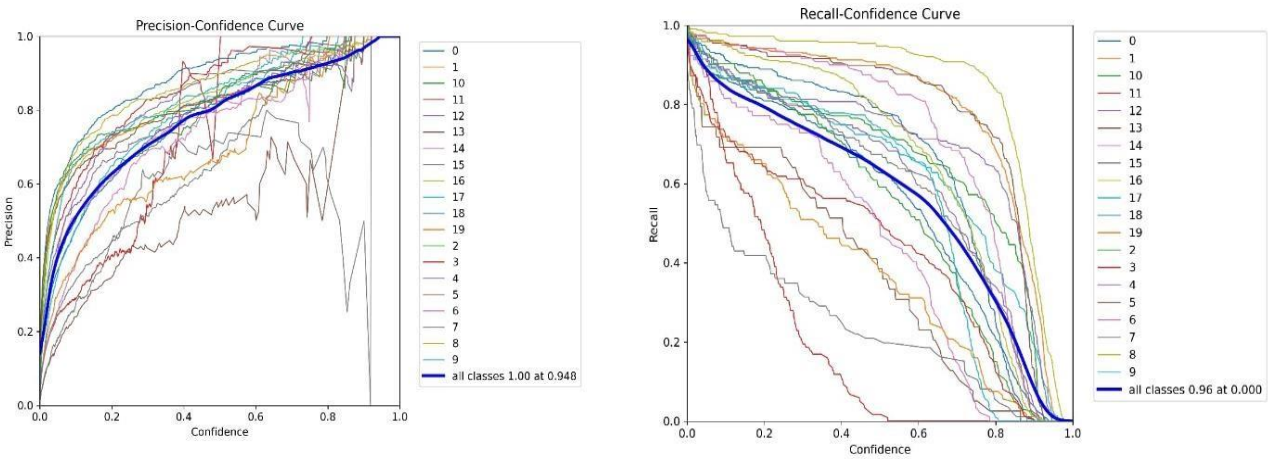

Fig 5.2 – YOLOv7 Model Accuracy and Loss

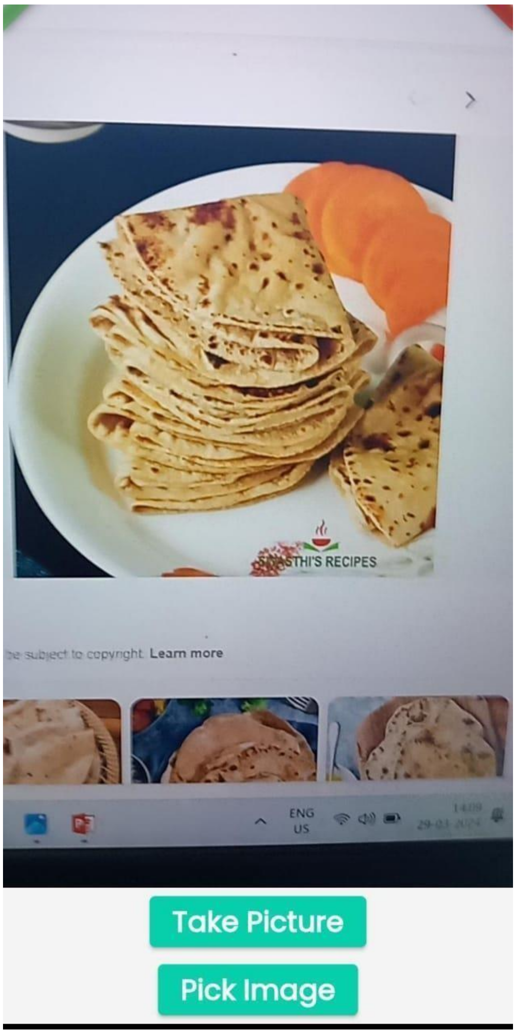

Fig 5.3– Captured Image Result

Fig 5.4 – Image Nutrient Details

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When we tested these models together with ensemble based approach using a real mobile captured food image we got nearly average 80% of accuracy.

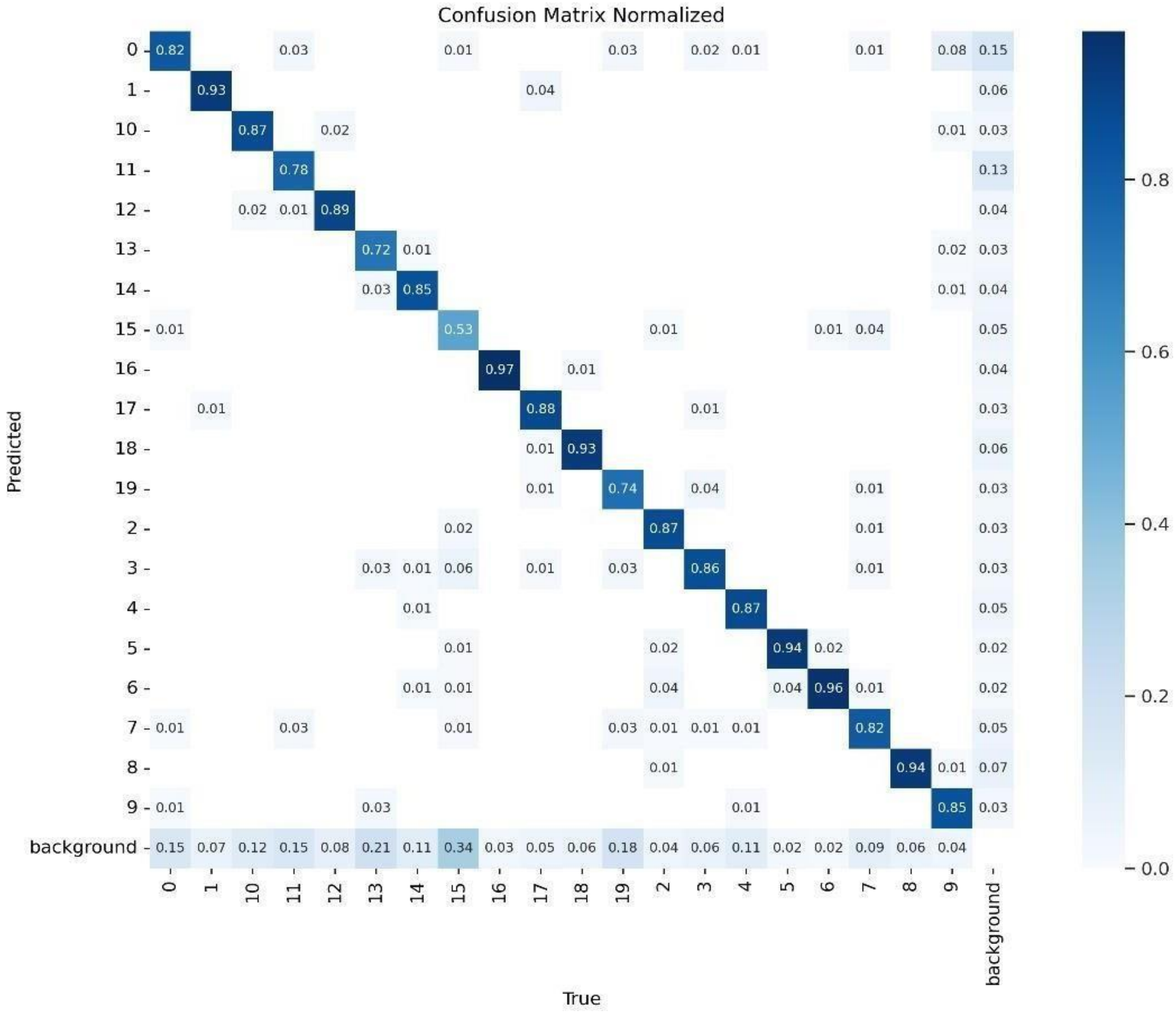

Fig 5.5 - Confusion Matrix

A confusion matrix is a table that is used to evaluate the performance of a machine learning model by comparing the predicted and actual values of a classification problem. It is a matrix of true positives (TP), false positives (FP), true negatives (TN), and false negatives (FN).

The confusion matrix is a valuable tool for measuring the accuracy, precision, recall, F1- score, and other performance metrics of a classification model. It helps to understand how well the model is performing on each class and how it is making errors**.**

VI. CONCLUSION AND FUTURE SCOPE

In conclusion, the utilization of deep learning convolutional neural network (CNN) models for food classification based on image data holds immense promise. These models exhibit high accuracy and robustness in identifying food items, benefiting from their ability to learn intricate patterns and features.

To start with, we list the food items that are mostly eaten in India from various regions. As a result, we collected a variety of food images and uses bounding boxes to identify the location of each food images. Our eventual dataset, restrain images more than 9736 with annotations of 15,000 + annotations. Our custom dataset allows us to train and compare

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YOLOv7, and YOLOv8 algorithms owing to both their high accuracy and speed. According to the results, all algorithms appear to perform ample with respect to accuracy and accomplish more than 0.80 mAP. In terms of accuracy, YOLOv8 reports the best performance with a mAP of 0.96, whereas it takes the 4ms fastest inference time with YOLOv7 which is 0.92. Furthermore, we consider the implication of model selection which is based on deployment requirements:

We hope that our work will contribute in detecting more food items and serve people in recognizing food objects more accurately. For Future we would like to increase the datasets and also increase accuracy of nutrients stored in the database.

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