WHAT A PREGNANT LADY SHOULD EAT: A MACHINE LEARNING EMPOWERED WEB-BASED APPLICATION TO DETECT FOOD

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled **"What A Pregnant Leady Should Eat: A Machine Learning Empowered Web-Based Application to Detect Food"**, submitted by Name: Sabria Alam Bishal, ID: 201-15-3143 to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on ***26-01-2024.***

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I hereby declare that, this project has been done by us under the supervision of **Dr. Md. Taimur Ahad, Associate Professor and Associate Head, Department of CSE** Daffodil International University. I also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

It's critical for the growth of the fetus as well as the health of the mother to get enough nutrients throughout pregnancy. Women need special attention throughout pregnancy. Maintaining a balanced diet and sufficient nutrient intake are essential. Unfortunately, a significant percentage of Bangladeshis are unaware of this issue. The people that suffer the most are new moms, as they have never encountered this circumstance before. Major pregnancy issues might result from an unbalanced diet and incorrect fruit consumption at this period. To overcome this challenge, we applied a deep learning technique called You Only Look Once (YOLOv8) to identify and categorize various fruit varieties. A varied dataset of foods pertinent to prenatal nutrition is used to modify and train the YOLOv8 model, which is well-known for its real-time object identification skills. The system's goal is to make it easier for expectant mothers to keep an eye on their food consumption and encourage a nutritious, well-balanced diet for the duration of their pregnancy. We have separated our eight fruit classes into two main groups according to whether they are avoided or useful. We obtained data about fruit eating during pregnancy from online health journals and papers as well as gynecologists. Reading our article will help people understand which of our eight fruit types to consume and which to avoid. Pre-trained YOLOV8 models were implemented. This study contributes to the field of maternal healthcare by providing expectant mothers with a novel tool that facilitates informed dietary decisions. The YOLOv8-based food detection technology enhances maternal and fetal health outcomes while also increasing knowledge of nutrition. Further research endeavors might concentrate on enhancing the efficacy of the model, integrating customized nutritional suggestions, and investigating its utilization in more comprehensive healthcare settings.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

A unique set of physiological changes and increased nutritional needs that are critical for both the growing baby and the expectant mother characterize the transforming journey that is pregnancy. A healthy pregnancy and optimum fetal growth are contingent upon enough nourishment for the mother. Understanding how important it is to keep a balanced diet during this crucial period, technological developments provide new ways to assist expectant mothers in making educated food decisions. You only look once (YOLOv8) has emerged as the most popular image recognition technique in the deep learning space. Large volumes of data may be handled more effectively with this method. We could extract visual imagery data with annotations and use it to train our system using a deep learning approach. Different image detection challenges may be handled by a variety of deep learning methods. Deep learning algorithms must be appropriately taught and assessed in order to improve accuracy. Pregnancy is a time when a woman's health should come first since neglecting her health might be harmful to the fetus as well as the pregnant mother. In Bangladesh, pregnant women do not understand the importance of food. Much of the population of the nation is impacted by their poverty and lack of literacy. Most women are not even aware of what they are consuming. Many are clueless on what to eat or stay away from throughout this period. Pregnant women should eat fresh fruits since they are packed with nutrients that can prevent malnutrition. Approximately 75% of moms think that the main factor for children to be malnourished is malnutrition in the mother.

In addition, a few fruits are bad at this time of year. The growth and development of a newborn is negatively impacted by this kind of fruit. An miscarriage may sometimes arise from this [1] [2].

Table 1.1: Overall food chart for women conceiving.

Useful	**Avoided**
Apple	Alcohol
Bitter_Gourd	Raw eggs
Cabbage	Raw meat
Chichinga	Pineapple
Chickoo	Grapes
Bean	Papaya
Kakrol	Unwashed Fruits and Vegetables etc.
Mango	High-Mercury Fish
Orange	Undercooked Fish
Pointed_Gourd	
Tomato	

A variety of seasonal meals that come with the winter months might provide special nutritional advantages for expectant mothers. A pregnant woman's diet can benefit from include these winter-specific foods to support the unique demands of the developing fetus as well as her general well-being. The following are some possible advantages of winter meals for expectant mothers:

Rich in Vitamin C: Winter brings an abundance of citrus fruits, including clementines, oranges, and grapefruits. Vitamin C, which helps the body absorb iron, boosts immunity, and promotes the growth of healthy skin, is abundant in these fruits.

Iron-Rich Foods: Winter is a good time to eat dark greens like Swiss chard, kale, and spinach. These veggies are rich in iron, which is essential for sustaining the increased blood volume and avoiding iron-deficiency anemia during pregnancy.

Seasonal Berries: Although certain berries are accessible all year round, some, like cranberries, are especially connected to the winter months. Antioxidants found in berries help support a strong immune system.

Warm and Cozy Drinks: Winter is the ideal season for warm and cozy drinks. Herbal beverages with relaxing properties, such chamomile or ginger, might help ease typical pregnant discomforts like nausea.

To satisfy their unique nutritional demands, pregnant women should ensure that their diet is diverse and well-balanced and should consult with healthcare specialists. A healthcare physician should be consulted before making any substantial dietary adjustments, as individual dietary requirements may differ.

Aside from that, sustaining a nutritious and well-balanced diet is essential for the mother's and the growing baby's health throughout pregnancy. On the other hand, because of their possible negative effects on pregnancy, several foods and substances should be avoided or used sparingly. The following food list should be avoided due to health risks for expectant mothers:

Undercooked Fish: Possibility of bacterial or viral contamination resulting in foodborne diseases that might be dangerous to the growing fetus, such salmonella or listeria.

Alcohol: Pregnancy-related alcohol use is associated with fetal alcohol spectrum disorders, which can cause the unborn child to have physical, behavioral, and intellectual problems. It is advised that pregnant women avoid alcohol.

The general health of the expecting woman and the unborn child is greatly enhanced by making educated food choices throughout pregnancy.

The YOLOv8-based food detection system has the potential to revolutionize maternal nutrition in the digital era. In the parts that follow, we will examine its methodology, implementation, and validation. Through this study, we seek to bridge the knowledge gap between advances in technology and maternal health, as well as encourage a more informed and healthy pregnancy experience.

1.2 Motivation

A mother nourishes and supports the growth of a new life inside her throughout pregnancy, which is a life-changing experience. We are driven to provide pregnant moms with the resources they require to make wise decisions for their health and the health of their unborn children because we understand the critical role that nutrition plays in this amazing process. We find inspiration for the field of maternal nutrition in the idea of a future in which technology is incorporated into the pregnant journey in a seamless manner. Our incentive is to take advantage of state-of-the-art developments, particularly in the form of pregnant woman-specific food detection technologies. Through the utilization of the YOLOv8 concept, our goal is to develop a revolutionary experience that goes beyond conventional methods of food tracking. Pregnant ladies need extra attention, as we all know. Women must be aware of the healthfulness of the food they consume in order to maintain a balanced dietary intake. Making ensuring kids are getting a nutrient-dense food chart at this point is crucial. For nutritional balance, they may add certain foods, fruits, or vegetables in this chart. We are surrounded by an abundance of reasonably priced fruits. But not every fruit on this list is healthy for a pregnant person or her fetus. Fruits rich in vitamins such as calcium, a mineral iron, vitamin B12, C, D, and A should be chosen by women at this period. [3]. In addition to fruits that contain latex, fruits that cause the mother's body to produce heat should also be avoided [4]. Therefore, we are trying to answer this dilemma in this research by combining various fruits in order to discover if they are useful or hazardous for pregnant ladies. For the purpose of detecting and identifying food, I decided to use an advanced deep learning technique called YOLOv8.

1.3 Rationale of the study

Among the most difficult things about nutrition is identifying food and fruit, especially when it comes to different kinds of food and fruit. In this research, we present a model to detect and correctly distinguish different types of food using enhanced YOLOv8. We have tagged all 1238 of the food-related photos in our primary dataset using the YOLOv8 format. Based on the different kinds of fruit, our dataset is categorized into 15 groups across all images. In this field, YOLOv8s have previously been used in several investigations. Researchers study a variety of topics for a variety of issues. They used a variety of datasets such as those related to food, traffic signs, people, animals, diseases, etc to complete their tasks or create new ones. They work on food detection in various documents for any given country's regulations, such as those pertaining to food in Germany, Sweden, Belgium, the Netherlands, France, the United States, and so on. In this article, however, we are making a contribution to the development of a model for identifying fruit and food that is suitable for expectant mothers. However, we are establishing a model in this research that can be utilized globally to identify food, which is providing a significant function.

1.4 Objective

To identify and categorize various food kinds, we shall use a You Only Look Once (YOLO) in our study. Classifying fruits and foods has been the subject of much study, although this particular issue has not received as much attention. Thanks to its automated learning and very little pre-processing, YOLO is more optimized than other image recognition techniques. This deep learning approach can distinguish between different types of imagery data, and large-scale imagery data is currently being used extensively in the field of image detection due to its high efficiency rate and simple architecture. On our collected dataset, we are using the YOLOv8 model. Almost every platform is compatible with this device. We have examined various viewpoints and decided to use this deep learning model. This study's primary objective is to create, test, and verify a sophisticated food detection system tailored for pregnant women based on the YOLOv8 (You Only Look Once) paradigm. By giving expectant mothers precise, up-to-date information about the nutritional value of their meals in real time, this cutting-edge system is expected to transform the way expectant mothers approach their dietary practices.

By achieving these goals, this research hopes to offer a game-changing solution that will enable expectant mothers to make educated and healthier food decisions, thus enhancing the health of both the mother and the fetus.

1.5 Research Questions

i. How have we handled this vast amount of data?
ii. In deep learning, which method will be suitable for pregnant women to identify food?
iii. What is the effect of using the YOLO (You Only Look Once) object identification algorithm on the precision and instantaneous functionality of a food detection system designed to track pregnant women's food intake?
iv. How does the interface improve the user experience for expectant mothers looking for nutritional guidance? What are the main obstacles and factors to be taken into account while creating and executing an easy-to-use interface that incorporates the YOLO-based food recognition system?
v. How do pregnant women's eating habits and nutritional decisions get affected by a YOLO-based food detection system, and what can be learned from user reviews and comments about how well the system works to encourage better nutrition during pregnancy?

1.6 Expected Outcome

Our research will help pregnant women avoid fruits that are harmful to their health and nutrition, as well as deep learning techniques (YOLO) for object detection. Also, this study will contribute to a better understanding of deep learning methods (YOLO) for object recognition, particularly for new women who have no past experience with pregnancy nutrition. There are various regional fruits and foods all over the globe; however, the fruits we described in our research were from the viewpoint of Bangladesh.

1.7 Report Layout

I suggested YOLO (You Only Look Once) models for fruit picture identification and recognition in this paper. It is divided into 6 sections, which are shown below:

As the most crucial section of our report, we completed the identification section first. Next, it was our goal to begin writing on this document. introducing ourselves and outlining the general purpose of our website in the abstract. Afterwards, we organized the introductory section, which explains the purpose, justification for the investigation, research question, anticipated results, financial component, and, finally, the design that I am now elaborating on. The background section now contains the problem's scope, difficulties, related work, literature review, and study summary. Subsequently, research methodology addresses specific subjects and tools, data gathering procedure, statistical analysis, suggested approach, prerequisites for implementation, etc. The experimental setup is then covered, along with the data and analysis. After that, there is a discussion of the experimental findings and their justifications. The effects on the environment, society, ethics, sustainable practices, and related topics are covered in the section that follows.
I provide a summary of the work, make recommendations for future research, and draw conclusions in this part. The last section provides a summary of the results along with recommendations and implications for further study.

CHAPTER 2
BACKGROUND STUDY

2.1 Introduction

This chapter will provide an overview of the topic, a description of the research, an assessment of the literature, and an account of all the challenges I faced throughout my investigation. In the literature review chapter, I examined many research papers that were pertinent to my inquiry and spoke about the writers' approaches, categorization systems, and accuracy. In the part on the research summary, I discussed the shortcomings of other relevant publications. I described the solution using our YOLO technique, staying within the confines of the subject chapter. In the difficulties chapter, I also discussed the problems I ran into while doing my research.

2.2 Literature Review

In order to recognize and classify photographs, deep learning has been employed extensively in research. To describe their work in object detection, several academics use the YOLO (You Only Look Once, version 8) concept.

A group of researchers has advanced the field of food detection by developing ensembled models that combine CNN, YOLO, and other models. Improving fruit and food detection's accuracy and efficiency is their main goal. Shil et al. (2022) [5] One such nation is Bangladesh, which has high temperatures, high humidity, and substantial seasonal rainfall typical of a tropical monsoon climate. Bangladesh is home to a vast array of tropical and subtropical fruits. The fruits that are cultivated most often include papaya, tamarind, watermelon, pomegranate, plum, banana, litchi, lemon, guava, wood apple, mango, jackfruit, and pineapple. Given the diversity of fruits available in Bangladeshi marketplaces, automated fruit identification is crucial. This thesis introduces an automated deep learning-based fruit identification model that grades fruit quality and identifies fruits using image processing and deep learning architecture. For the experimental assessment, we will utilize our dataset of fruits from Bangladesh. In order to recognize, categorize, and assess fruit items based on their freshness, this thesis proposes a unique Convolution

Neural Network (CNN) structure known as VGG19. The object detection accuracy of the VGG19 application for Keras is quite high. The results illustrate our method's unique worth and indicate that it performs better than the linear predictive model. Li et al. (2022) [6] this study proposes a machine vision-based autonomous system for the perception of food and nutritional information in smart homes. Initially, we proposed using the social robot to monitor the user's food intake using a YOLOv5-based food detection algorithm. Second, in order to ascertain the nutritional makeup of the user's diet, we devised a technique for determining food nutritional composition and calibrated the weight of food items. Subsequently, we suggested an autonomous machine vision-based perception approach (DNPM) for dietary nutritional data, which makes the quantitative analysis of nutritional content easier. Finally, the proposed technique was tested on the self-expanded dataset CFNet-34, which is based on the Chinese food dataset ChineseFoodNet. The test results, which show an average recognition accuracy of 89.7%, show the great accuracy and robustness of the food-identification algorithm based on YOLOv5. The performance test results, which showed an average nutritional composition perception accuracy of 90.1%, a response time of less than 6 ms, and a speed of higher than 18 fps, demonstrated the excellent robustness and nutritional composition perception performance of the dietary nutritional information autonomous perception system in smart homes.

The emergence of food detection systems based on smart homes has caused a shift in public perceptions about nutrition tracking and diet care. Jia et al. (2023) [7] in this evaluation, in the area of determining food safety and quality, we provide an overview of the most current advancements and uses of colorimetric sensors. We start off by talking about the fundamentals, benefits, and drawbacks of machine vision. Subsequently, advancements pertaining to food poisoning and food applications, such as food quality and categorization, were examined. The area of machine vision-based colorimetric sensors (MVBCS) for determining food safety and quality has also been emphasized, along with its present difficulties and potential future developments. Sooner or later, food safety and quality should be enhanced by the use of MVBCS in everyday life. Monalisa et al. (2023) [8] with the use of augmented reality, the Dia-Glass system can identify the kind of food by taking images of it in real time and calculate its calorie content using a deep CNN approach. A specific mobile application linked to the specifications will be used. The device will alert users by showing the total calories via the eyewear when the daily calorie intake recommended for the diabetes patient is exceeded. The accuracy of the Faster R-CNN for food identification is 98.33%, which increases the system's reliability in categorizing different meals and drinks and calculating their calorie content. The program gradually changes the users' perspective to avoid consuming excessive amounts of calories, which helps manage diabetes and other diseases that need dietary adjustments.

Low- and lower-middle-income nations' Ramadan fasting customs and nutritional modifications are little understood. There hasn't been much research done on the sociodemographic factors that influence pregnant women's diet variety in low-income nations. Shamim et al. (2016) [9] pregnant women who have greater educational performance, whose husbands work in business, live in homes with four or more family members, and reside in a residence with more than one room had a considerably higher mean diet variety score (4.28). The three dietary categories with the highest reported knowledge and consumption gaps were dairy products, eggs, and dark green leafy vegetables. Women from lower socioeconomic backgrounds consumed less dairy products and eggs, but there was no discernible correlation between their sociodemographic traits and their intake of green vegetables.

Xiang et al. [10][11] suggested a technique for classifying photos of fruit using a lightweight neural network called MobileNetV2, which was pre-trained using the ImageNet dataset. A conv2d layer and a Softmax classifier are used in lieu of the base network's top layer. In their dataset, they obtained an accuracy of 85.12%. In the future, new data may be added to achieve greater accuracy. Yadav et al. [12] suggested a method for automatically classifying food images using two deep learning approaches: SqueezeNet and VGG-16 Convolutional Neural Networks. Using the Food-101 dataset, selected ten categories of Indian cuisine. Because of the network depth in VGG-16, they achieved a higher accuracy of 85.07% after implementation, outperforming SqueezeNet. The network or layer will provide more accurate results than the suggested model if we deepen it. Accuracy could potentially be impacted by increasing the number of iterations. Yeasmin et al. (2013) [13] in this studied, our goal is to use qualitative methodologies to investigate and comprehend pregnant British Bangladeshis' eating habits and views. Our findings suggest that eating more of specific foods might lead to favorable connections that will guarantee healthful effects. We also see that the physical and emotional health of pregnant Bangladeshi women is impacted by migration. We draw the conclusion that good healthcare, knowledge of customary eating customs and beliefs, and their integration into national and local policy agendas may result in positive changes and enhance pregnant women's general health.

Jhuria et al. (2013) [14] suggested an artificial neural network-based image processing approach to track fruit illnesses from planting to harvesting. They used two databases: one was utilized for query image implementation and the other was used for training previously recorded illness pictures. They completed their assignment with 90% accuracy. Different measurements may be employed in the future to improve performance. Liming et al. (2010) [15] suggested a machine-vision system that uses three criteria—shape, size, and color—to automatically assess strawberries in order to boost their economic worth. They sorted the strawberry hue using the a* channel and used the K-means clustering approach to the picture of the fruit. They obtained classification accuracy of 90% and 88.8% for shapes and color, respectively. More data with smaller error sizes may be used in the future to increase accuracy. Dang et al. (2010) [16] suggested an image processing-based method for identifying and rating fruit size. Here, they have used detecting algorithms to obtain many fruit attributes from a side view photograph that was captured. Experiments show that this embedded grading system has low cost, quick speed, and good grading accuracy.

2.3 Summary of the related research work

Table 2.1: An overview of the related research work with various cutting-edge techniques for identifying meals for expectant mothers.

Author	Year	Dataset Name	Method	Accuracy (%)
Li et al.	2022	Chinese food dataset ChineseFoodNet	YOLOv5	82%.
Yamparala et al.	2020	different types of fruits	CNN	85%
Xiang et al.	2019	ImageNet dataset	MobileNetV2	81.12%.
Yadav et al.	2021	Food-101 dataset	SqueezeNet and VGG-16 Convolutional Neural Networks	83.07%
Proposed method		Bangladeshi food (vegetable)	YOLOv8	84%

2.4 Research Summary

Many data mining and deep learning techniques have previously been used to successfully complete many picture identification and detection jobs. YOLO and its several kinds of models have already shown that they can carry out jobs using increased efficiency and precision. In the literature review chapter, we examined a wide range of picture identification and detection techniques employing diverse visual imaging datasets.

We have not yet found any research papers on the subject we have selected. There are several research on fruit identification and illness detection, but none that use deep learning to identify the preferred fruits of pregnant women. We may infer from this fact that there isn't any literature that directly relates to this subject. The literature evaluation states that CNN performs better and offers more accuracy on a variety of visual imagery data sources.

2.5 Scope of the Problem

After a thorough review of several studies on picture identification and detection, a common problem emerged: the incompatibility of the datasets utilized and the models that were suggested. A large percentage of these datasets showed a lack of volume in the data, which made the models less effective. There were also issues with the quantity of courses used for training, which suggests that there is not enough room for thorough model learning. The literature frequently showed a strong dependence on the VGG-16 design, which has a comparatively small number of layers. Because of the intrinsic limits of models with fewer layers, this architectural choice inevitably resulted in decreased accuracy. Understanding that these issues must be resolved, scientists have worked to improve model performance by the introduction of adjustments, as demonstrated by models such as YOLO. These updated models perform better than their predecessors thanks to the layer augmentation, especially when it comes to picture detection accuracy.

Inspired by these developments, we have decided to start building a deep learning model that breaks free from the limitations found in earlier studies. We are dedicated to using a larger and more varied dataset for training in order to reduce problems with dataset compatibility. Furthermore, we recognize the necessity of broadening the class range in order to enable a more sophisticated and skillful model. Rather than following the widely used VGG-16 structure, we use a model architecture with more layers, in line with recent advances in deep learning YOLO models. This is a calculated move meant to use the power of a more complex model that is ready to capture complex characteristics and patterns with greater precision. We are optimistic about this model's compatibility with contemporary technology because of its scalability and versatility in a range of application scenarios. In summary, our motivation stems from the need to address the problems we have discovered in the existing literature and develop a more complex, contemporary deep learning YOLO model. By doing this, we want to not only advance the current state of picture identification and detection techniques but also establish new standards for efficiency and accuracy in the field of deep learning research.

2.6 Challenges

Since I was trying to classify fruits for expectant mothers, i was confused about why i had chosen to include 12 different fruit groupings in our data collection. Then, to have a clearer picture of the circumstances, I consult with a gynecologist. I had some problems getting data from the internet and capturing images from local market in my village. There were several low-resolution photos. Additionally, there were far too many blurry and identical picture files online. I have made changes to the conventional YOLOv8 design to increase accuracy. However, in the end, i managed to go over every challenge and achieve a high level of accuracy.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Research Subject and Instrumentation

I created a speedier method to recognize and classify fruits, which will facilitate expecting women' fruit detection and identification. My mission is to help every expectant mother choose fruits wisely throughout her pregnancy. In our research, I used the "You Only Look Once" (YOLO) principle. I used my smartphone to take pictures of the local market and compile the statistics and other information.

Each of these photos was taken under various lighting circumstances, in various settings, and in various amounts of time. Actually, in order for our dataset to function accurately, we employed 16 classes of data, and it contains 1238 high-resolution photos. We utilized a dataset of food and fruit detection for our suggested model, using 991 photos for training and 247 photos for testing. These pictures were all taken using cell cameras at different angles. Fruits and vegetables such as Apples, Bananas, Bitter_gourds, Cabbage, Chickoo, Chichinga, Lady_fingers, Mango, Oranges, Papaya, Pointed_gourds, Radishes, and Tomatoes are among the sixteen types of utilized food that are listed here. Despite this, we employed the picture augmentation method in this instance, which is why the volume of our dataset has increased.

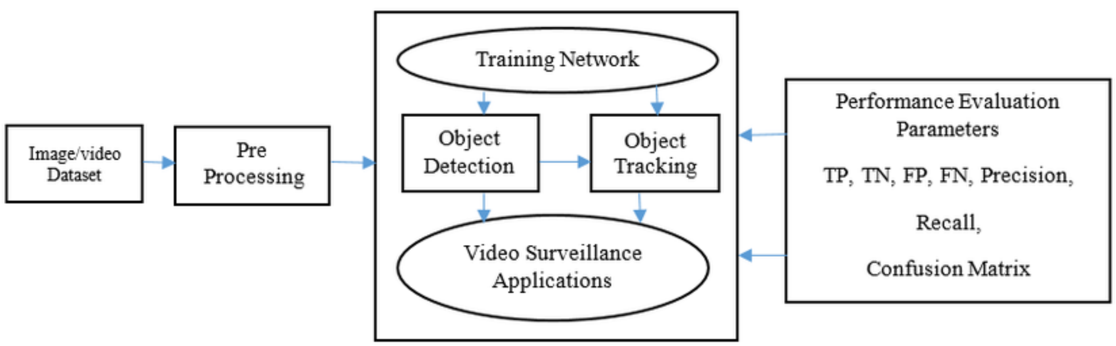


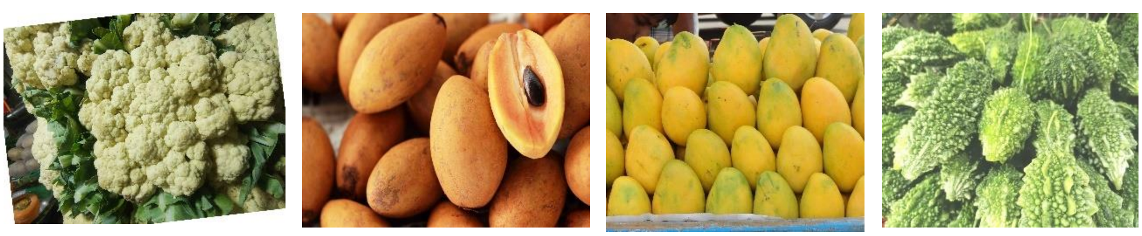
Figure 3.1: This Research Methods Block Diagram.

3.1.2 Fruit description

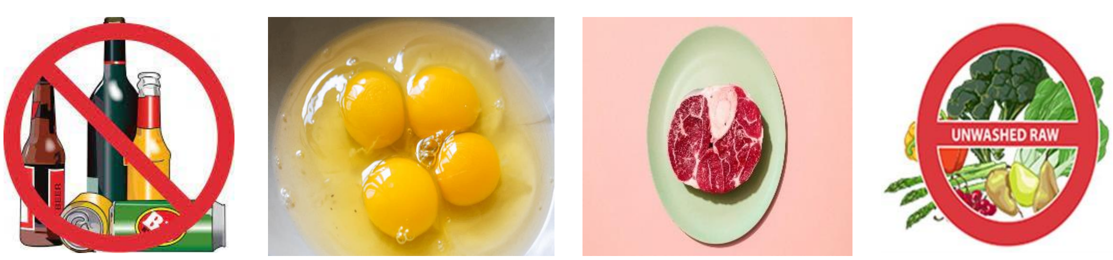
This was my research's most important component. It instructs us on what fruits to eat and what to avoid while a pregnant woman is around. Fruit provides my bodies with a range of beneficial elements, including fiber, antioxidants, vitamins, and minerals. However, certain fruits may be harmful to the fetus as well as the mother while she is pregnant.

In my compilation of healthy fruits, we include four particular fruits: Bitter Gourd Cabbage Apple Banana Chichinga, Chickoo, Bean, Kakrol, Lady's Finger, Mango, Orange Pointed Gourd, Radish Red Potato. Because they aid in the growing development of the unborn child, these fruits are extremely advantageous to a pregnant woman's health.
In addition to papaya, other food that should be avoided during pregnancy are Alcohol, raw eggs, raw meat, pineapple, grapes, papaya, unwashed fruits and vegetables, high-mercury fish and undercooked fish etc. These fruits produce heat in our bodies and contain latex and enzymes. These fruits may create issues connected to pregnancy if consumed while pregnant. Even taking these fruits in excess might lead to issues like miscarriage.

Now the image of some food and fruit is shown in the Figure 3.2



BENEFITS



AVOID

Figure 3.2: Eat (Chickoo, Banana, Mango, Bitter_Gourd etc) additionally Avoid (Alcohol, Raw_eggs, Raw_meat, Unwashed_raw).

3.2 Dataset Collection and Description

Using a wide range of online resources, we carefully selected photos from our dataset to ensure that it represented a variety of situations. Furthermore, we collected data in-person in nearby markets using smartphone cameras to take pictures of actual fruit. This dual method adds a thorough representation of fruits experienced in different contexts to our dataset by integrating digital resources with local market information. It was imperative that we select photos with sufficient resolution that were clear and fresh. We collected 991 picture data points from 12 distinct fruit and food varieties.

Table 3.1: The distribution of the gathered photos by class

Name	Photos
Apple	84
Bitter_Gourd	100
Cabbage	100
Chichinga	100
Chickoo	22
Hyacinth_Bean	100
Kakrol	100
Mango	48
Orange	38
Papaya	100
Pointed_Gourd	99
Tomato	100
Total	**991**

All the photographs were resized to 744 × 744 pixels and their resolution was decreased using Pillow. A Python computer language package called Pillow offers free access to a range of picture file formats for accessing, modifying, and saving.

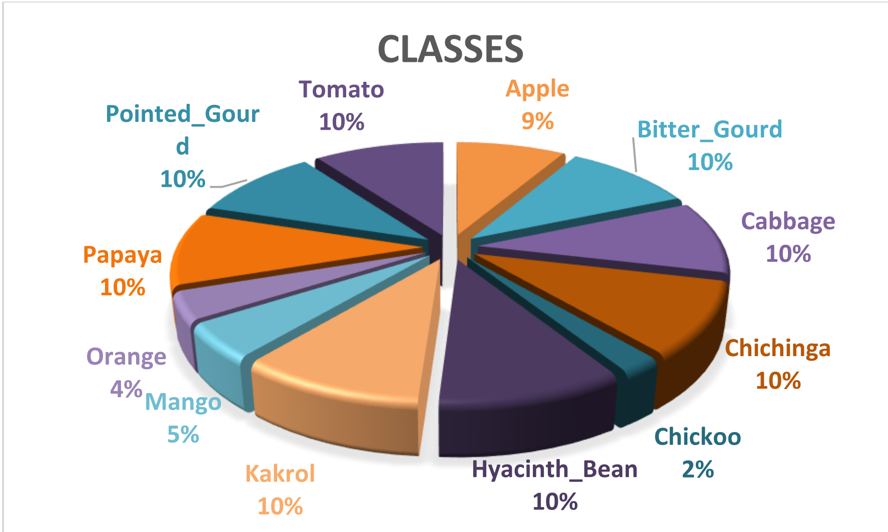


Figure 3.3: Percentage of different class.

3.3 Statistical Analysis

As a single-stage object detector, YOLOv8 is a structural method that can be used to develop any model on any type of dataset. These designs are crucial to adhere to as they make it simple to handle several systems in a process that can be sequenced and governed. For instance, the YOLOv8 architecture consists of three crucial components:

1. Backbone Network
2. Neck Layers
3. YOLO Heads

In the end, we continue to run our model through this three-step procedure, and we find that the YOLOv8 technique performs best on photos that are a part of a certain process and have dimensions of (744 * 744). It appears that pictures have been scaled from our gathered information and are put in various dimensions. In this case, resizing is the most crucial factor since it makes it simple to include all of the provided data and annotate every image. Following that, resized photos went through all three YOLOv8 phases.

Backbone Network: At the precise moment that I extract all relevant attributes from the supplied photographs in my dataset, my input photos pass through the main layer of the core stage. While lowering resolution, this layer gives images a sense of depth. Afterward, the BottleNeckCSP's outputs [17]. Meanwhile, separate feature extracts are being retrieved for other photographs. The SPP layer will get the output when this step is finished. This procedure may be followed to appropriately treat the stage and maybe identify the true cause of the issue. Conversely, the question of why this process is referred to as the "backbone stage" is crucial for this section to comprehend, but it is also vital to note that we are employing the primary concerns to store and process this information with appropriate justification. It is also known as the pooling layer as a result layer.

Neck Layers: The SPP (Spiral Pyramid Pooling) block receives the output from BottleNeckCSP in order to increase the receptive field. Next, enumerate the necessary attributes. Compared to prior YOLO (You Only Look Once) based model layers, this SPP is superior since it can handle input photographs of any size. The final objective of the SPP layer is to provide an output with a fixed dimension. Significant qualities are identified by the SPP layer via the creation of a multi-scale version. When discussing the helping hand, it is evident that we must comprehend the procedures involved and their acceptable justifications. However, I also need to be sufficiently informed about this subject to comprehend the actions that will follow and the information that will be supplied in order for me to respond effectively.

YOLO Head: Finding the last stage in the process is the aim of this stage, with the head stage mostly taking care of the final detecting phase. Subsequently, we include anchor boxes into our processed data to enable visible resizing. In summary, the process generates a result including many classifications, including bounding boxes, probabilities, and objectiveness ratings, much like the grid sale we conducted in the first rounds.It really occurs in this process to be transparent, understand the possibilities, and be aware of some of the challenges when it comes time to discuss the actual issue to resize. This process really completes a couple of difficult jobs.

To sum up:

Backbone: Utilizes the input picture to extract features.

Neck (PANet): Improves context and spatial awareness by combining features from several scales.

Head: Predicts using the refined characteristics, such as class probabilities, bounding box coordinates, and objectness scores.

Owing to its three-stage design, YOLOv8 can effectively identify and categorize things in real-time, which makes it appropriate for uses like object recognition in pictures and videos. Due to its ability to balance speed and accuracy, it is a well-liked option for computer vision jobs.

Figure 3.4 here displays the YOLOv8 architecture's primary structure.

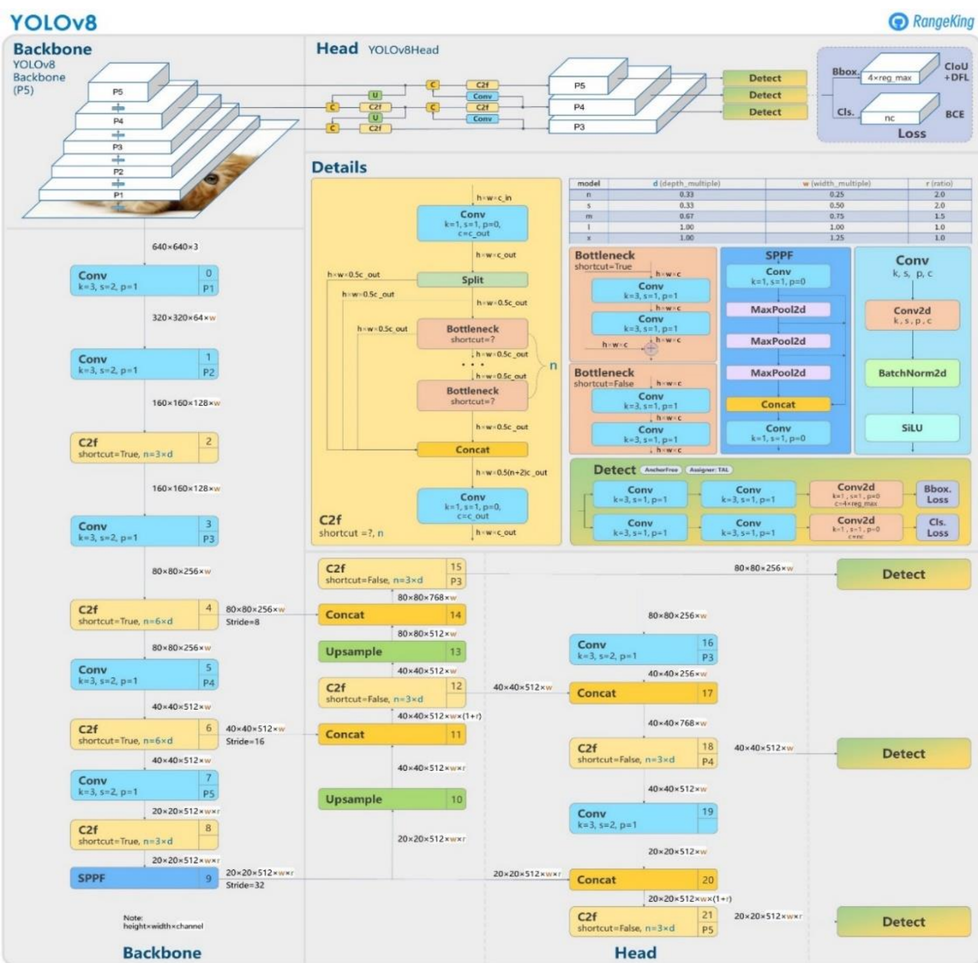


Figure 3.4: The YOLO model stage architecture's structure.

Labels:

A text file is usually included for every picture in your dataset that corresponds to YOLOv8, or any other variation of YOLO (You Only Look Once). These text files provide details on the items shown in the picture, such as their class and bounding box locations.

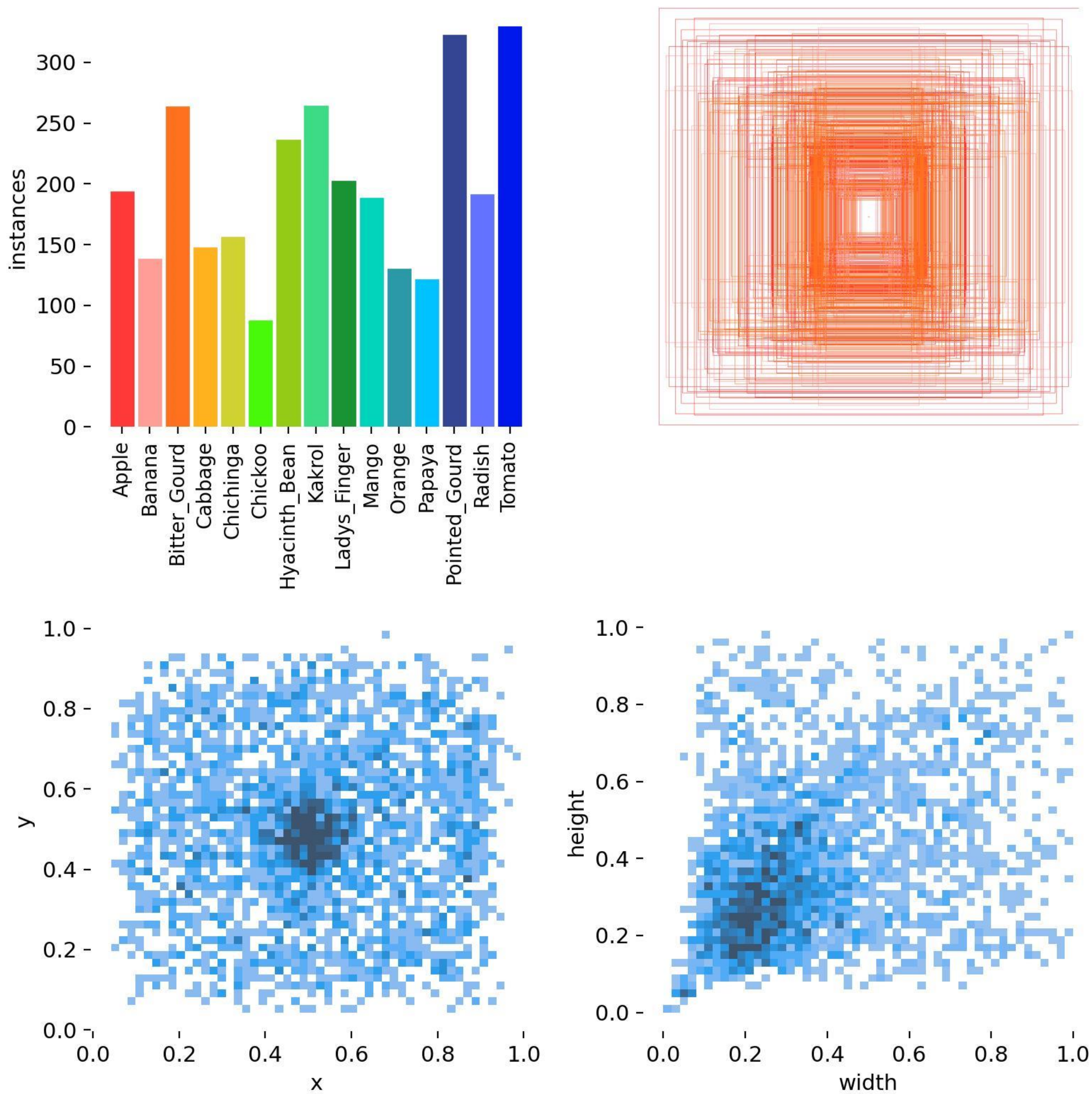
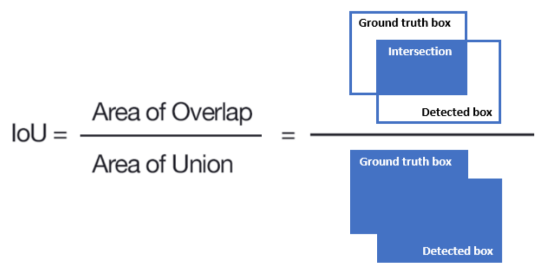


Figure 3.5: Labels for dataset.

Before going into great detail with object identification using the important assessment metrics, it is necessary to grasp a few basic concepts. Whatever happens at this point, keep an eye on those problems and control the actual procedure so that you can grasp the situation and be clear. However, we can handle all of those problems with ease and make an effort to be unique while discussing those specific subjects in order to communicate clearly. Before we get into the topic of object detection, let's review a few helpful definitions:

Intersection over Union (IoU):

Within this case, IoU initially assesses the intersection area between the anticipated bounding box and the ground truth bounding box. Then, divide the bounding box union area (shown in the figure) by the intersection area. The prediction may be split into two categories for each of them: True Positive, which is genuine, and False Positive, which is not [20].



True Positive (TP): TP indicates how accurate the detection was. A threshold is imposed once the forecast's accuracy or error has been determined using the IoU ratio.
Typically, a threshold of 50%, 75%, 85%, or 95% is used. The behavior of the outputs may be controlled by adjusting this threshold. Any object detecting system, for instance, will perform well at a 50% threshold but poorly at a 95% threshold.

False Positive (FP): This indicates a false positive. In this case, The ratio of IoU must be below the cutoff.

True Negative (TN): Nothing was picked up by the object detection model. The model's prediction that there isn't an item in the image is accurate.

False Negative (FN): It indicates that there was no detection by the item. The object is in the image, but the model was unable to recognize it.

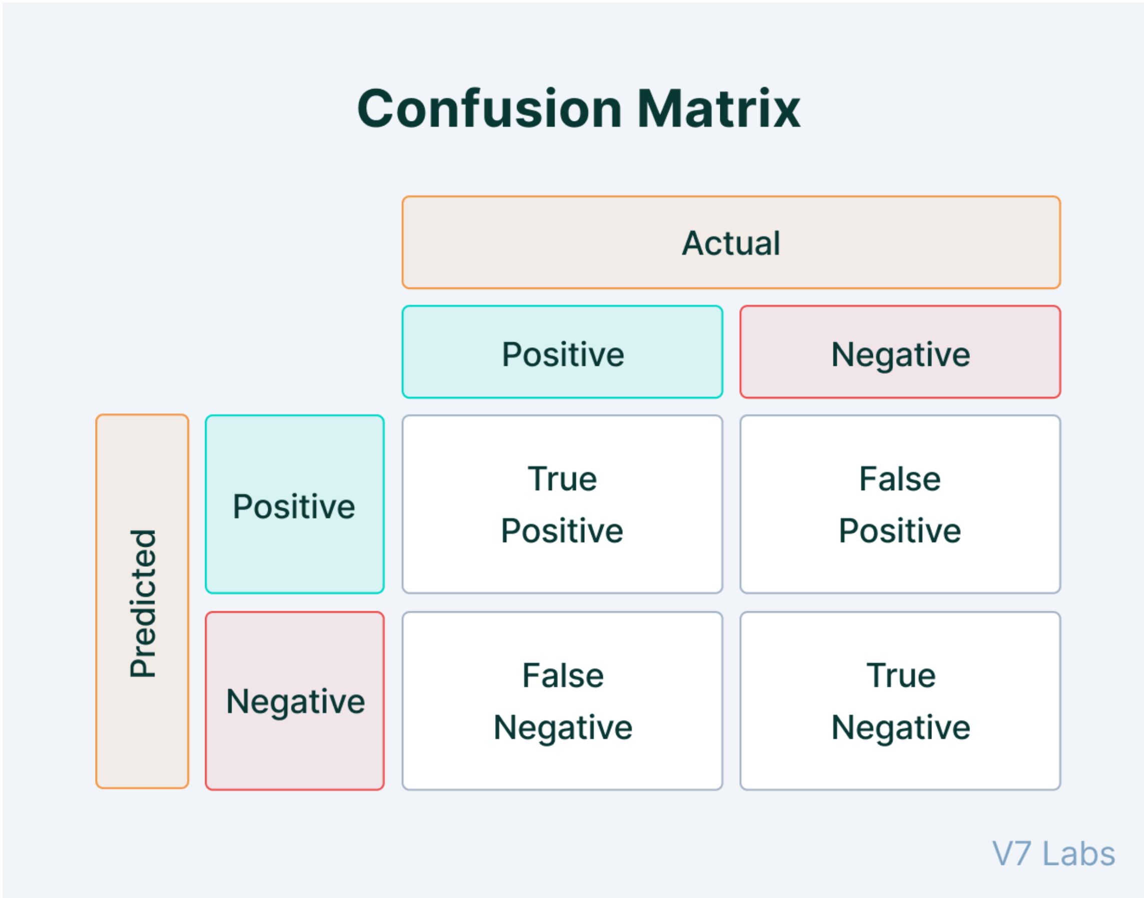


Figure 3.6: Confusion Matrix of mAP.

We utilize precision-recall, a valuable success metric, to find the maximum of the unbalanced class times. Precision remembers the actual relevant results that were returned and depicts the relevant results [19].

Precision (P): For every given collection of data, it is defined as the total of the true positives (Tp) and false positives (Fp).

$$P = \frac{Tp}{Tp+Fp} \qquad (1)$$

Recall (R): In terms of both true positives and false negatives, the ratio of true positives (Tp) to false negatives (Fn) is how it is defined.

$$P = \frac{Tp}{Tp + Fn} \qquad (2)$$

Equilibrium mean (F1) of accuracy and memory:

$$F1 = 2\frac{P \times R}{P + R} \qquad (3)$$

Average precision (AP): the precisions obtained at each entrance weighted mean, where the weight denotes the increase in recall from the prior entry.

$$AP = \sum n\ (Rn - Rn{-}1)\ Pn \qquad \mathbf{(4)}$$

A pair (Rk, Pk) is referred to as an operational point. Pn and Rn are the precision and recall at the nth entry.

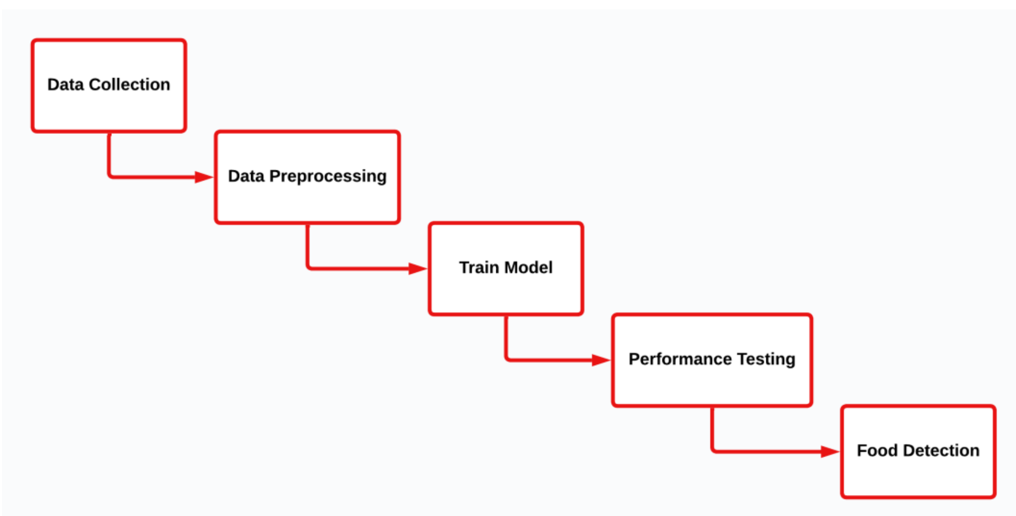


Figure 3.7: Process flow of the model we suggested and utilized to identify food.

3.4 Proposed Methodology

Proper image annotation is necessary to build a model that can identify objects from images or videos with accuracy. Annotating photos with a model allows for more accurate and unambiguous item recognition and classification. One of the most difficult aspects of this approach is annotating images correctly and assigning them the value they deserve before using them for their intended purpose. This is the section where the true content of a picture or video, together with the system's processing mechanism, may be readily understood. However, a picture or video that we now have in our dataset might have a variety of problems, such unwanted size, ambiguous content, and other problems. But, throughout this procedure, we may simply control the system to comprehend the actual picture or facts that we now possess. All things considered, we can state that annotation of photos in grid sells—where the image and data are cleanly and easily understood—is a very significant component for us.

System administrators must reload these pictures in order to adjust their size. A picture must be perfectly clear in terms of its size when it initially enters the system, among other things. Following the resizing process, the system calls the annotated image, which completes the last step of understanding the picture by obtaining the required clearance. We also annotate our photographs to ensure proper operation of our model. We accomplished this by utilizing the Makesence Website and LabelImg Software to annotate each image of fruit and food. With the aid of this program, we finished two jobs related to photo annotation that we had previously finished by hand: bounding boxes and class labels. When the picture annotation reaches its apex, we construct a rectangle box around the various foods and name each one separately while it is facing distinct object images. After that, the file is saved in XML or txt with all of the bounding boxes labeled. After which we change this file's extension to Yolov8 PyTorch (.txt). We may now begin our process more quickly and precisely, but it still needs a legitimate method to launch this model correctly and operate it efficiently.

3.5 Implementation Requirements

First, I collect the photographs of food from local market, preprocess each one, add captions, and organize the pictures into several categories. It's accurate to state that, to start, we had two datasets: the real dataset that we previously had and the trained model. To be clear, though, we had to handle all those difficulties. The most crucial factor is that each of the datasets include almost infinite amounts of data that are simple to handle and operate correctly. I execute those two datasets on the series of all the datasets. Finally, i ran across a challenge with accurately containing all the data. Modify the YOLOv8s technique to learn our model in the train model step. Next, in the next step, assess the model's performance on images of fruit using the test dataset. In the end, this model aims to accurately identify or detect pictures of food and fruit.

I used Jupyter Notebook to reduce the image quality and downsize them. RAM constraints have caused a reduction in image quality. We save our photo dataset on Google Drive. My YOLO models are trained using Google Colab. Python 3.8 was used to conduct our research.

CHAPTER 4
EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Experimental Setup

I used PyTorch as the framework for my Python coding for my thesis project, and my main workstation was Google Colab. Rather of using COCO weights that have already been trained, I produced a unique model by modifying the data flow and class count. For my model, there were 100 epochs in the training procedure. During the testing phase, I ran Windows 10 Anaconda on an AMD(R) Ryzen (TM) 4800H CPU running at 2.9GHz and an NVIDIA Graphics 3050 GPU. The dataset consisted of 991 high-resolution photos, of which 793 were set aside for training and 197 for extensive testing.

I am very happy with the outcome as it demonstrated to the system as a whole that it can locate all data with ease and at the appropriate desired value. On the graph, we may observe the metrics curve, or the mAP carve. Nevertheless, the curve is far too simple to grasp when the right justification and graph are provided. The model's map's calculation value completely clears the graph with the outcome.

4.2 Experimental Results & Analysis

Mean Average Precision (mAP), which is the main measure used to evaluate the efficacy of this detection model, indicates the accuracy of item identification in the next trial: the greater the rate of mAP. Now, the following formula may be used to get the value of mAP:

$$mAP = \frac{1}{N}\sum_{i}^{N} APi \quad (5)$$

The region of the Precision-Recall Curve (PRC) is given by APi, where N is the total number classes of objects and i is the label of a class.

4.2.1 YOLOv7:

The optimal mAP value in our food and fruit identification model is shown in Figure 4.4, and once again, we have 69% precision and 70% recall.

Figure 4.3 shows our training model's accuracy and recall curve in the last epochs. However, to assess the model's prediction and look for ways to make it work better, the validation dataset was utilized using a confusion matrix. Every training session, the model's performance was assessed using data from validation as well. Once again, table 4.3 displays the values of recall (70%) and precision (69%) both in the experimental result and during the validation period for each class. Here, table 4.2 displays the mAP comparison for every fruit and food category at (IoU=0.5).

Figure 4.5 confusion matrix in the context of a food detection YOLO (You Only Look Once) model, especially for expectant mothers. Involves assessing how well the model performs in determining whether or not food items that are appropriate for pregnant women are present.

Object identification technique After dividing a picture into grid cells, YOLO projects bounding boxes and probabilities of classes onto every cell in the grid. The YOLO model's performance may be assessed using the confusion matrix, especially in terms of how well it recognizes meals that are suitable for pregnant moms. It offers information on how well the model is able to differentiate between items that are safe for pregnancy and those that are not, allowing for any necessary corrections and enhancements.

The ultimate anticipated outcome of the food and fruit identification process with the model we developed is shown in figure 4.

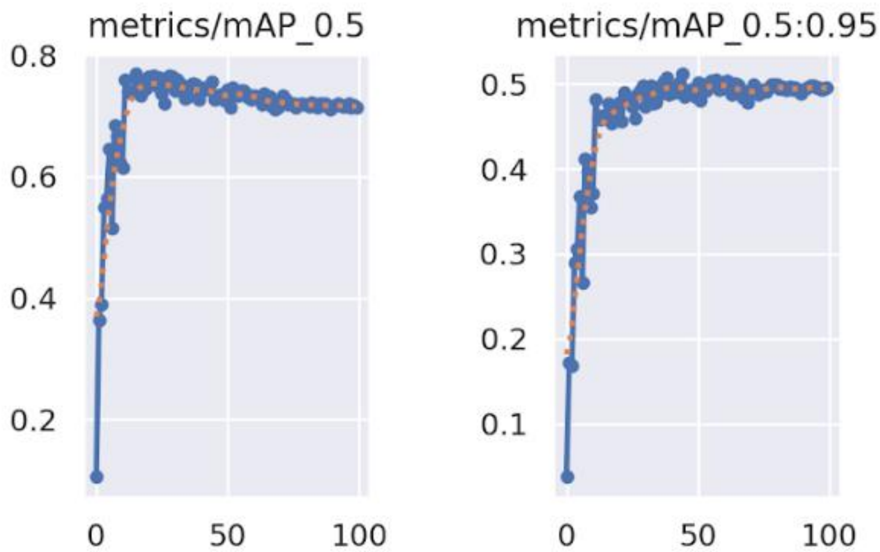


Figure 4.1: The model's maximum mAP value indicates the most accuracy it can deliver over all epochs.

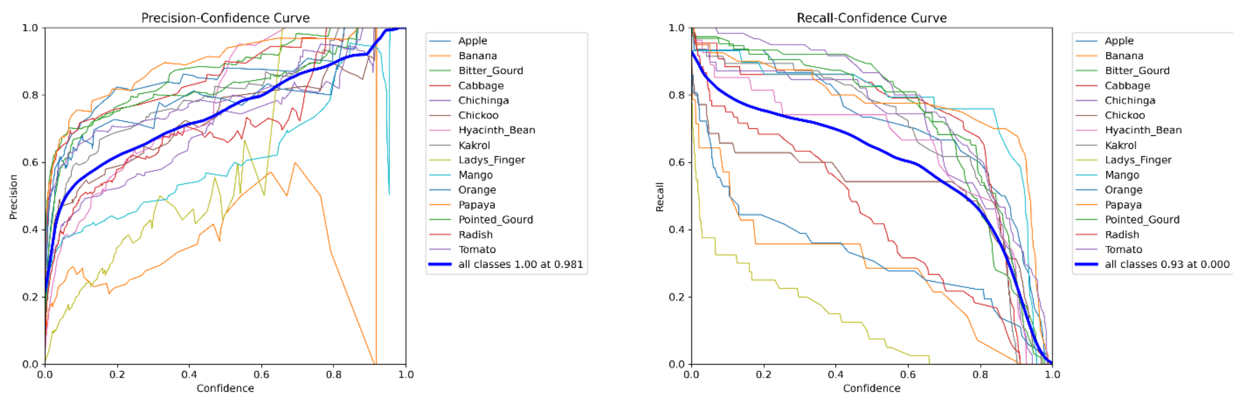


Figure 4.2: The Precision and Recall curve at the end epochs of our training model.

Table 4.1: To display the accuracy rate for each class.

Classes	**Scores**		
	Precision	Recall	Map50-95
Apple	0.83	0.83	0.72
Bitter_Gourd	0.87	0.92	0.65
Cabbage	0.81	0.86	0.57
Chichinga	0.62	0.84	0.49
Chickoo	0.70	0.6	0.47
Hyacinth_Bean	0.68	0.74	0.59
Kakrol	0.76	0.85	0.52
Mango	0.53	0.86	0.64
Orange	0.78	0.36	0.41
Papaya	0.89	0.82	0.80
Pointed_Gourd	0.79	0.87	0.65
Tomato	0.77	0.93	0.74
Total/Avg	0.69	0.70	0.52

Table 4.2: Comparison of mAP amongst Categories when IOU = 0.5.

Classes	**YOLOv7**
Apple	0.81
Bitter_Gourd	0.79
Cabbage	0.98
Chichinga	0.78
Chickoo	0.67
Hyacinth_Bean	0.82
Kakrol	0.80
Mango	0.82
Orange	0.72
Papaya	0.89
Pointed_Gourd	0.89
Tomato	0.94
mAP	0.76

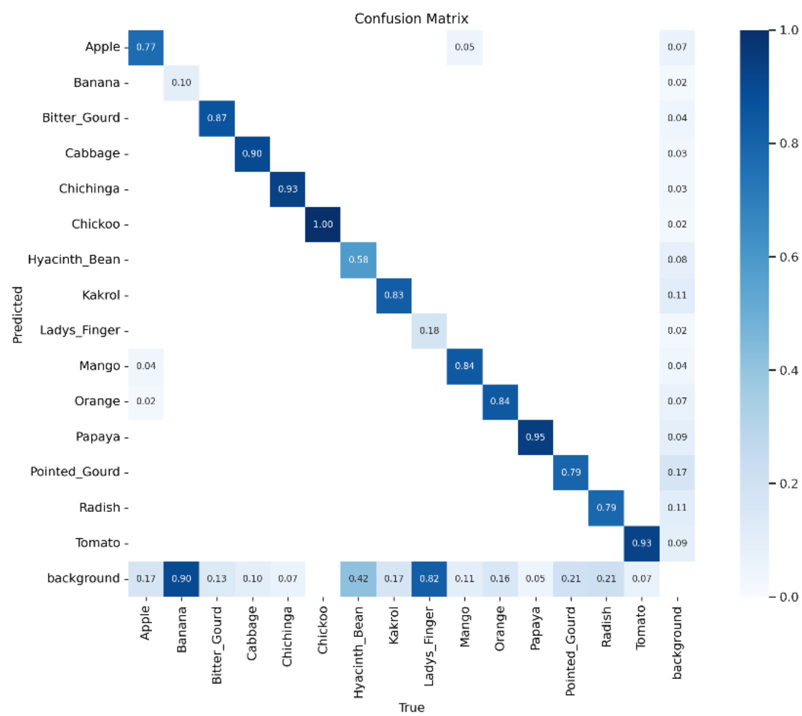


Figure 4.3: Confusion matrix in the context of food detection Yolov7.

4.2.3 YOLOv8:

The optimal mAP value in our food and fruit identification model is shown in Figure 4.7, and once again, we have 77% precision and 74% recall.

Figure 4.8 shows our training model's accuracy and recall curve in the last epochs. However, to assess the model's prediction and look for ways to make it work better, the validation dataset was utilized using a confusion matrix. Every training session, the model's performance was assessed using data from validation as well. Once again, table 4.3 displays the values of recall (74%) and precision (77%) both in the experimental result and during the validation period for each class. Here, table 4.2 displays the mAP comparison for every fruit and food category at (IoU=0.5).

Figure 4.5 confusion matrix in the context of a food detection YOLO (You Only Look Once) model, especially for expectant mothers. Involves assessing how well the model performs in determining whether or not food items that are appropriate for pregnant women are present.

Object identification technique After dividing a picture into grid cells, YOLO projects bounding boxes and probabilities of classes onto every cell in the grid. The YOLO model's performance may be assessed using the confusion matrix, especially in terms of how well it recognizes meals that are suitable for pregnant moms. It offers information on how well the model is able to differentiate between items that are safe for pregnancy and those that are not, allowing for any necessary corrections and enhancements.

The ultimate anticipated outcome of the food and fruit identification process with the model we developed is shown in figure 4.7.

Object identification technique After dividing a picture into grid cells, YOLO projects bounding boxes and probabilities of classes onto every cell in the grid. The YOLO model's performance may be assessed using the confusion matrix, especially in terms of how well it recognizes meals that are suitable for pregnant moms. It offers information on how well the model is able to differentiate between items that are safe for pregnancy and those that are not, allowing for any necessary corrections and enhancements.

The ultimate anticipated outcome of the food and fruit identification process with the model we developed is shown in figure 4.

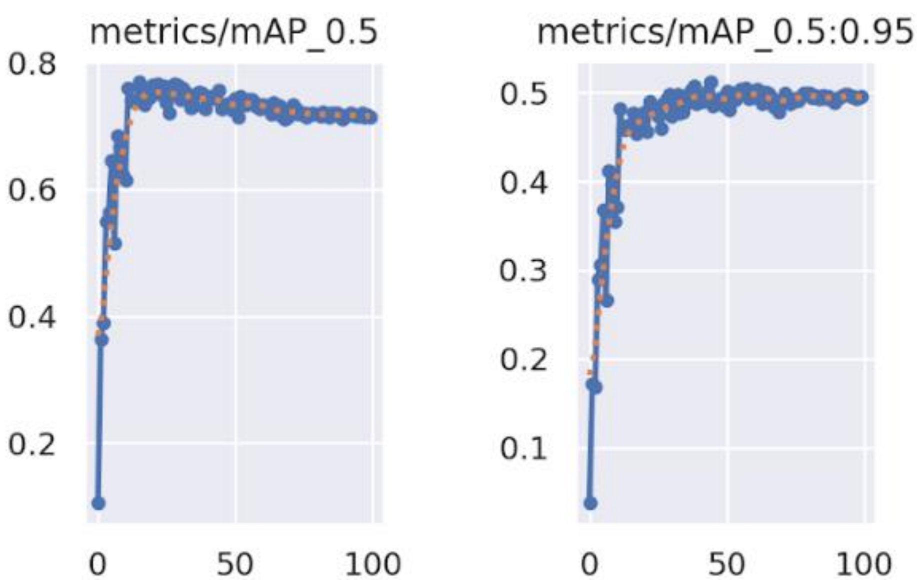


Figure 4.4: The model's maximum mAP value indicates the most accuracy it can deliver over all epochs.

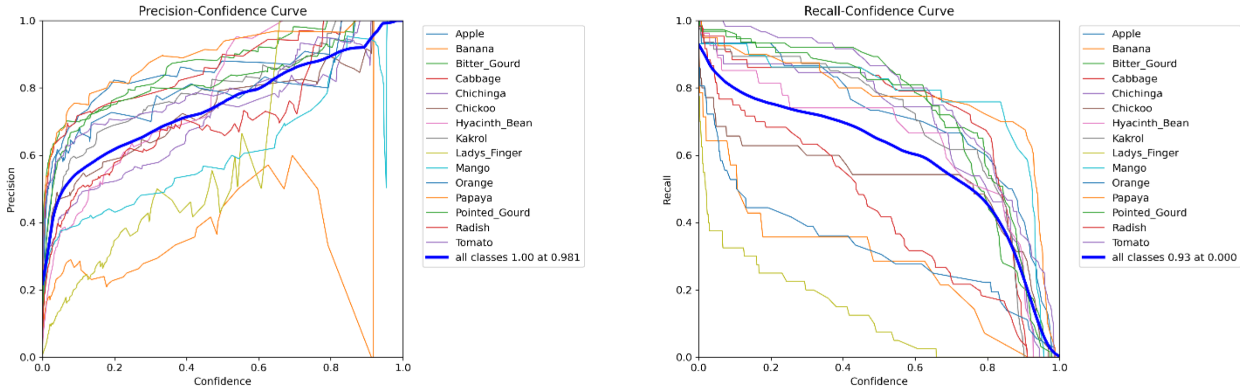


Figure 4.5: The Precision and Recall curve at the end epochs of our training model.

Table 4.3: To display the accuracy rate for each class.

Classes	**Scores**		
	Precision	Recall	mAP50-95
Apple	0.81	0.73	0.67
Bitter_Gourd	0.77	0.89	0.59
Cabbage	0.81	0.94	0.65
Chichinga	0.51	0.73	0.40
Chickoo	0.86	0.71	0.60
Hyacinth_Bean	0.92	0.65	0.48
Kakrol	0.80	0.77	0.48
Mango	0.75	0.60	0.47
Orange	0.65	0.8	0.60
Papaya	0.72	0.81	0.74
Pointed_Gourd	0.77	0.74	0.61
Tomato	0.82	0.83	0.76
Avg	0.77	0.77	0.59

Table 4.4: Comparison of mAP amongst Categories when IOU = 0.5.

Classes	**YOLOv8**
Apple	0.85
Bitter_Gourd	0.90
Cabbage	0.94
Chichinga	0.66
Chickoo	0.87
Hyacinth_Bean	0.87
Kakrol	0.83
Mango	0.76
Orange	0.81
Papaya	0.86
Pointed_Gourd	0.84
Tomato	0.93
mAP	0.84

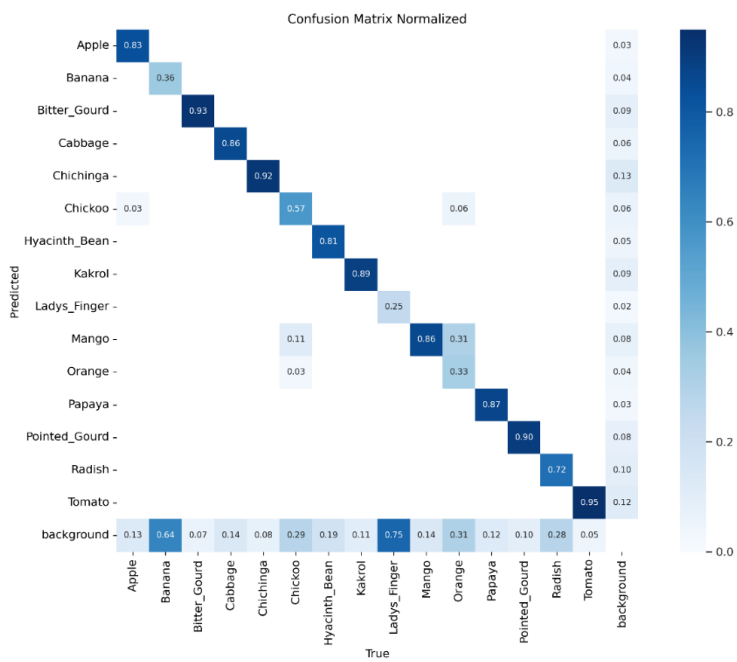


Figure 4.6: Confusion matrix in the context of food detection Yolov8.

Table 4.5: The final accuracy of all models Comparison of mAP when IOU = 0.5.

Model	Accuracy
YOLOv7	76%
YOLOv8	84%

Figure 4.7: Final output of my model.

i. In YOLOv7 the Average Precision value for each i is provided by APi. After the last epoch is complete, we find that the mAP value is 76% at IoU 0.5 but 52% at IoU 0.95.

ii. In YOLOv8 the Average Precision value for each i is provided by APi. After the last epoch is complete, we find that the mAP value is 84% at IoU 0.5 but 59% at IoU 0.95.

Here we can see the final result we got result according to YOLOv7 76% and got highest accuracy 84% from YOLO v8. So, we selected the YOLOv8 model for this research. To calculate the mAP value, the IoU thresholds of 0.5, 50% and 0.95, 95% have been defined. assuming a value of 0.95 to 0.5 is chosen as the IoU cutoff point.

4.3 Discussion

To complete our entire system Initially, we began working with Google Colab, which was a simple tool to utilize for any machine learning procedure. Knowing the true problems with this program and how to use it are the most crucial things. However, we used Google Colab to begin our machine learning process. By the way, we discovered all those Yolov8, Yolov7 internet codes. It would not be too difficult to run our dataset using other alternatives, such as yolov5, yolov4, yolov3, yolov2, and so on, as each of them has a unique code that can be found online along with the actual dataset.

We used Google Colab's standard edition when we first started our project. When we tried to use our system with the complete dataset, we ran into a lot of difficulties. Overall, there were a lot of photographs in our dataset, which was rather enormous. Unfortunately, our large dataset was too much for the regular Google Colab version to manage, even with a fast internet connection. This led to early project dissatisfaction, which made us put our thesis work on hold and look for other answers. We decided to investigate the idea of utilizing Google Colab's free version to handle our issues after coming to a turning point. We were optimistic that this version might manage our dataset effectively despite our initial misgivings. We thought the free version could still be able to handle our data well even if it is missing several capabilities. We eventually used the standard Google Colab version and were able to advance. Even though streamlining and optimizing our dataset took some work, we managed to get over the restrictions of the free version. Even while it was unable to match Google Colab Pro's capabilities, it nonetheless allowed us to carry out our task and efficiently handle the data.

Finally, even though the free edition of Google Colab had several drawbacks, it worked well for our deep learning system. We were nonetheless able to accomplish our objectives and effectively finish the project in spite of its shortcomings.

CHAPTER 5

IMPACT ON SOCIETY, ENVIRONMENT AND SUSTAINABILITY

5.1 Impact on Society

Encouraging the public to understand the importance of eating healthfully during pregnancy a critical period in a woman's life is our main objective in doing this study. Making sure pregnant moms get the nourishment they need during this stage is fundamental to their physical and emotional well. Fruits, known for their wide variety of vitamins and carbs, are essential for supporting the growth and well-being of moms and their offspring. But one common problem in our culture is that people don't know which fruits are good for pregnant women to eat. Certain fruits should be handled carefully or perhaps avoided completely because of their latex content, enzyme content, or heat-generating qualities. Our study aims to overcome this knowledge gap by focusing on recent moms who might not be familiar with dietary needs and wholesome fruit options. Through our research, moms may become more knowledgeable about fruits and make better decisions for their unborn children by learning about which ones are healthy and which ones could be hazardous. Equipped with this knowledge, people may take simple preventative measures such as knowing which fruits to avoid.

The improved accuracy of my You Only Look Once (YOLO) model, which I obtained by intensively training it using carefully gathered data, lends relevance to our work. Especially, my model is designed to work well with contemporary platforms, making it usable by a wide range of users.

My findings have a huge social effect. It helps people develop health-conscious eating habits, especially those who are not aware of the advantages of including fruits in their prenatal diet. My research offers valuable insights into the nutritional elements of fruit selections, which is in line with the overall objective of improving the health of mothers and their children. Making educated food decisions ultimately has a beneficial impact on family wellbeing and is a significant step towards a society that is healthier and better informed.

5.2 Impact on Environment

The ongoing increase in demand for fruits indicates a significant change in eating habits, with a rising inclination toward fruits over other foods. The way that people eat is changing, and this has important effects for the environment in addition to personal health. In a world where people are always becoming bigger, choosing fruits becomes a more sustainable way to meet your nutritional needs. Fruit demand is growing, which is good news for the environment because it means more trees are being planted. To accommodate the need for fruits, there has been a deliberate rise in tree planting, which benefits the ecology. By promoting biodiversity, helping to sequester carbon dioxide, and improving general air quality, trees are essential to the survival of the ecosystem.

That is to say, the growing trend of eating more fruit is in line with environmental health. Intentionally planting additional trees in response to the need for fruits is a good way to help the environment. As a result, the decisions we make as a society are actively working to create a healthier environment by emphasizing the connection between ecological sustainability and eating practices.

5.3 Sustainability Plan

Main objective of my research is to provide individuals a framework for understanding when it's appropriate to make fruit choices when pregnant, in an effort to raise awareness of the significance of these decisions at an early age. My findings might potentially be a useful tool for maternal health organizations by spreading this knowledge.

My goal is to lower the number of illnesses connected to pregnancy in accordance with a sustainability strategy. We hope to encourage a positive change in behavior that will reduce difficulties like miscarriage and delivery-related problems by arming people with knowledge on how fruit choices affect the health of mothers.

Through our study, these organizations may raise awareness and incorporate evidence-based insights into their initiatives, resulting in a long-lasting ripple impact that affects not just individual behavior but also broader health outcomes.

My goal is to contribute to the long-term health of pregnant women and sustainable health practices in communities by raising awareness at the individual and organizational levels.

CHAPTER 6

SUMMARY, CONCLUSION, RECOMMENDATION, AND IMPLICATION FOR FUTURE RESEARCH

6.1 Summary of the Study

My research on nutrition during pregnancy, we used a deep learning technique to select a broad range of fruits based on the specific nutritional needs of pregnant women. The processes that comprised the research process were data collecting, research methodology, implementation, outcomes, and analysis. Images from online sources were collected for our data collection, and the web tool makesense.ai was used to annotate the photos. We resized and enhanced the quality of the collected photos using Jupyter Notebook to provide the optimal feasible setting for model training. Following a comprehensive background inquiry and literature review, we selected the YOLOv8 model for implementation. This model is known for its capacity to detect and recognize pictures. The information, which thoroughly included a variety of fruit varieties and other significant pregnancy-related factors, was carefully arranged into 15 classifications. To streamline our deployment, we used pre-trained YOLOv8 ultralytics models as the basis for our model training on Google Colab, which proved to be a reliable platform. Much better than we had anticipated, the YOLOv8 model demonstrated exceptional object detection accuracy.

Our study's conclusions highlight the YOLOv8 model's exceptional performance and provide pleasant results using fresh data. This work adds significant knowledge to the field of picture categorization, especially as it relates to pregnancy nutrition. It highlights the YOLOv8 model's effectiveness in accurate and reliable item identification, with possible uses in pregnant women's food detection.

6.2 Limitations and Conclusions

We used You Only Look Once (YOLO) models to correctly identify 12 distinct fruits in my research on fruits identification and detection during pregnancy, displaying a high degree of accuracy in this challenge. Notwithstanding these successes, it is important to recognize some limits.

First off, my models might not correctly recognize any fruits outside of this collection because they were explicitly trained on 12 preset fruit kinds and other classes. A larger dataset would be needed to expand the model to include a wider range of fruits, which might result in better performance. A further path for future development may be to add additional layers to the network, which could further increase accuracy. Although the YOLO models we used with the selected 12 fruits showed remarkable performance, they might be improved even further by optimizing for a bigger dataset and more complicated models.

Let's sum up by saying that the YOLO approach has a great reputation in the picture detection and identification industry. With my particular picture dataset, our testing findings confirm the better effectiveness of my YOLO models. This is an especially good achievement because it sets the stage for helping people, especially expectant mothers, choose fruits and foods in an educated and healthful manner. Going forward, my study makes a significant addition to the field of maternal nutrition by helping expectant mothers feed their unborn children a nutritious diet. Health-related organizations might use my findings as a springboard for future developments in promoting appropriate nutrition during pregnancy in this technological age.

6.3 Implication for Further Study

Smart technologies have become a seamless part of our everyday life in this AI-dominated digital age. As cellphones become ever-present instruments closely linked to people, a major chance presents itself to enhance the usability and accessibility for our You Only Look Once (YOLO) models. Implementing these models in an application for Android would make sense as a further step toward giving consumers a more user-friendly interface. Exploring the creation and implementation of our YOLO models on the Android operating system is the implication for future research. With the use of smartphones, this investigation aims to enable people to evaluate the nutritional worth of different fruits quickly and intelligently. Because of their built-in mobility and accessibility, cellphones are the perfect platform for distributing these kinds of apps, enabling users to receive dietary data wherever they are.

Looking ahead, further research may focus on enhancing our YOLO models' functionalities. To continuously improve the model accuracy and performance, this might entail adding new fruit classifications and expanding the dataset. Promising prospects exist for the advancement of nutritional evaluation using smart, mobile technologies, thanks to the continuous improvement and development of YOLO models on the Android operating system.

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APPENDIX

Appendix: Research Evaluation

I provide a contemplative overview of my own experience working on this research endeavor in this appendix. Especially for activities like gathering data and interacting with new people, working alone on this study project proved to be gratifying and complicated. It was not as collaborative as group work, so I had to figure things out on my own and deal with different parts of the task. This solo trip revealed several noteworthy things, such how much longer it took to organize and decide than it did when everyone worked together. I had to take full responsibility for every step since there were no group dynamics present. I actively participated in the ongoing creation and improvement of concepts throughout the study project. These problems went beyond abstract ideas; they included actual work, including going to nearby marketplaces to get vital information. My supervisor's help in organizing the best practices for gathering datasets was very helpful, and I am appreciative of it. It was a fun and challenging experience to gather data from the local market. We were enriched by our interactions with the locals, who kindly provided support for our study. Evaluation of food detection techniques for expectant mothers is expected to benefit greatly from the knowledge acquired from these encounters and the data gathered.

The experience of doing independent research was enjoyable and challenging. The advancement of study on food detection for pregnant women has been greatly aided by the supervisor's assistance and the experiences acquired from connecting with local communities. However, even though independence required careful preparation and decision-making, it was still worth it.

Appendix: Associated Problems

I faced a lot of obstacles when doing my own study, which forced me to explore new areas of machine learning and deep learning methodologies. Acquiring knowledge of different algorithms, such as YOLO v7 and v8, turned out to be challenging yet insightful.

Getting pictures from the busy neighborhood market was one of the biggest challenges. Getting around the crowded area and maintaining the picture quality was a significant challenge. Taking the task upon myself, I went to the neighborhood market and spoke with vendors, asking for their assistance in taking pictures of various foods. Thankfully, the salespeople turned out to be kind and helpful, which helped this part of data gathering go well.

An additional challenge encountered throughout the study phase is the careful labeling of photographs. I approached this assignment with accuracy since I knew how important precise annotations were and that any errors may result in improper model training.

Despite these difficulties, the trip was worthwhile overall. My grasp of the study subject was further enhanced by the contacts with salespeople, the practical experience of collecting images, and the complex process of annotation. I want to use the information and abilities I've gained from this solitary research project to my advantage in the future.

WHAT A PREGNANT LADY SHOULD EAT: A MACHINE LEARNING EMPOWERED WEB-BASED APPLICATION TO DETECT FOOD

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