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# Intelligent Forest Assessment: Advanced Tree Detection and Enumeration with AI

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**A B S T R A C T**

Tree detection and counting are fundamental tasks in environmental monitoring and management, crucial for assessing forest health and biodiversity. This study presents a focused effort on developing a robust system for tree detection and counting utilizing the YOLOv8 model, known for its efficiency in object detection tasks. Augmented with Roboflow annotations, the approach ensures structured handling of annotated datasets, facilitating model training. The methodology involves optimizing the YOLOv8 model parameters to achieve high precision and recall rates, crucial for accurate tree identification across diverse environmental settings. Evaluation metrics such as F1 score, precision, and recall provide insights into the model's performance, balancing the trade-off between false positives and false negatives. The proposed system demonstrates promising results, accurately identifying and categorizing trees based on the YOLOv8 architecture, with potential applications in real-world forest management scenarios.

In addition to its fundamental role in forest management, our project aims to revolutionize tree detection and counting through the integration of machine learning techniques within the YOLOv8 framework. By leveraging these technologies, we automate the process of identifying and categorizing trees, streamlining environmental assessments. Furthermore, the system provides detailed tree counts categorized by height (Tall, Medium, Short), enabling precise monitoring of forest ecosystems. Through our innovative approach, we contribute to advancing environmental monitoring practices, enhancing the efficiency and accuracy of tree detection and counting tasks.

Keywords: Roboflow annotations, F1 score, YOLOv8 model, UAV technologies

## 1. Introduction

Tree identification is the approach of tallying the number of trees in a given quarter. it is an vital venture for timberland management, protection, and arranging. traditional strategies of tree be counted, including manual overviews or floor-primarily based reviews, may be time-eating, expensive, and willing to mistakes. photograph analytics offers a promising present day technique to tree depend. image analytics calculations may be applied to certainly distinguish and number trees in adherent imagery or airy photos. this could altogether lower the time and fetched of tree identification, and it is able to also improve the exactness of the comes approximately. in this challenge, we are going develop an photograph analytics framework for tree depend in timberland zones. The framework might be applied to help the authorities make educated picks about woodland redirection and to assure that the environment is protected.automatic tree vicinity and tallying utilizing high-decision farther detecting pictures has pulled inside the consideration of a huge number of analysts in later a long time. facts almost the shape, localization, and wellbeing of timber in manor zones is simple for shrewdly agribusiness to display the exceptional of tree development. The image procurement generally comes from satellites and Unmanned airy vehicles (UAVs). because of the short development of obsequious and UAV improvements, copious data have improve advanced the advancement of related tree detection and tallying technology.In not unusual, most existing techniques of tree place and tallying are focused on partisan pictures. first of all, the entire huge-scale inaccessible detecting image is part into loads of patches utilising the sliding window procedure. At that point classification or detection-primarily based techniques are utilized to distinguish and localize the objectives. At long ultimate, the discovery comes about from individual patches are melded into the whole far off-sensing picture. The obsequious system can be a capable tool for gazing errands, counting arrive cowl regulate region, hearth checking, city development, everyday calamity checking, and so on. As of past due, UAVs are becoming to be promising tools for purchasing 86f68e4d402306ad3cd330d005134dac images with low-price, light-weight, and excessive-frequency utilization, that have the capacity for extraordinary research and tracking spaces, counting natural looking at and research, genuine and brilliantly farming, and infection discovery. Be that as it may, what UAVs collect with digicam devices can be a arrangement of image information, and grouping picture discovery seem result in a part of duplication, which

isn't helpful and diminishes region skillability and high-quality in expansive scale locales. finally, airborne picture mapping will be a essential mission some time lately image analysis.In later many years, ethereal photo stitching has been utilized in parcels of situations, consisting of agrarian plant security, forest fireplace checking, timberland tree checking, submit-disaster assessment, and army examinations. For the maximum element, there are ways to comprehend airborne photograph mosaicing assignments. One is offline mosaicing, in which entirety pictures of a target locale captured with unmanned ethereal motors (UAVs) are dealt with and optimized collectively. This approach calls for coordinates vital information of captured pics for photo mapping, which by using and big ends in specific stitching comes about. the alternative is online mosaicing, with actual-time gauges. it's miles important in some exceptional utility situations like publish-catastrophe guard, navy surveillance, and tree resource insights, which are occasions that put a tall request on timeeffectiveness. In commonplace, the major contrasts between online and offline mosaicing are digicam posture estimation calculations and the 3D factor cloud technology method.shape From movement (SFM) and concurrent localization and mapping (Pummel) are conventional strategies utilized to gauge the digital camera posture and produce a factor cloud. After the digicam posture and point cloud are gotten with one of the above-mentioned tactics, the captured pics are at that factor expected to the right role with homography trade techniques.sooner or later, those discrete pics are melded to make a whole mosaic. Be that as it can, SfM techniques are important offline calculations with expensive computation, which places tall request on gadget conditions. as a result, it's miles badly designed to be sent on facet gadgets. by way of the way, long computations will decrease the by using and huge paintings proficiency and probable increment the time taken a toll, especially for large-scale planting measurements offered on this paper.For maximum Hammer strategies, a package deal alteration calculation is applied to gauge camera postures and refine point of interest positions; landmark positions are the important thing include focuses collectively watched with severa pix. in spite of the truth that the SLAM-based totally actual-time framework is faster than the SfM-primarily based mapping framework, the step of package alteration remains time-consuming for real-time development frameworks and the coordinating execution is terrible beneath moo cowl conditions. To remedy these troubles, a multiplanar speculation-based totally posture optimization approach is proposed to estimate digicam postures and bring mosaicing at the same time. This appear quicken the calculation speed and achieve vigorous stitching execution with consecutive low-overlap photographs inside the implanted devices.most of the early works targeted on encompass representation plan for tree tallying and discovery assignments. some tremendous handcrafted highlights like Scale-invariant highlight exchange (filter out) and histogram of arranged gradient (HOG) had been to begin with utilized to extricate key focuses. At that point classifiers like bolster vector machine (SVM), Random Timberlands, k-manner] and great getting to know device (ELM) were carried out to gain the goal tree place undertaking utilizing the above-referred to customarily hand made highlights. All things taken into consideration, the invention scenes are reasonably fundamental; the timber are meagerly disseminated and simply sketched out and not using a cover covering. therefore, conventional handcrafted capabilities-primarily based techniques may also carry out the errand nicely. Be that as it is able to, those strategies are not quit-to-end structures, and they include of a few partitioned calculation steps that might deliver greater startling commotion or mistakes because of careless facts shipping between partitioned calculations.

In expansion, hand made include constructing calls for luxurious computation and endeavors that depend upon master facts which is not efficiently gotten for different shrewdly assignments.Neural networks (CNN) were a success in lots of fields in latest years, together with pc vision, language processing nature, prognosis, and so forth. because of their studying capacity. existing research may be divided into search-based, segmentation-based, and regression-primarily based methods. For hint-based totally evaluation, researchers accumulate massive quantities of tree information for deep mastering (DL) algorithms to examine key factors for tree computation or other item discovery tasks. CNN framework and complete monitoring gadget quicker R-CNN is designed for oil palm or other end result to be detected by way of rubbish series. For the segmentation-based totally monitoring approach, some seek capabilities based on U-net and completely convolutional neural networks (FCN) are used to estimate the visual representation of timber within the photograph, the photograph is taken, and the quit of the containing masks is made. pictures and images. big tree. To remedy the extreme problem, the "click, click-cast off" regression-based approach has attracted humans's attention. In this situation, researchers estimate the location and variety of human beings simultaneously by way of estimating the density map the use of annotation factors. but, this technique simplest estimates the common position and ignores the scale and form of the goal object. To calculate trees quickly and successfully in UAVs, this paper gives a tree calculation based totally on weak supervision of deep mastering, that may keep away from highly-priced container or masks income. not only the truth of the timber is taken, however also the mask of the products; in comparison to different strategies (such as masks-R-CNN), our method requires less education records, which makes it appropriate for small research regions. to check and demonstrate the robustness of the proposed approach, it has been used in numerous places (e.g., a city in Bangalore, India, and a woodland area in Gatto, Germany) and different types (WorldView-three satellite and overhead). -line photos).

## 2. Literature Survey

As part of the Literature Survey, we have referred few project papers, and the findings from them are:

[1] The S. Patil, Y. M. Patil, and S. B. Patil, "Detection and Estimation of Tree Canopy using Deep Learning and Sensor Fusion," 2023. the unique idea of “precision agriculture” seeks to boost the production and efficacy of agriculture. Growers are better equipped to monitor every step of the production process and administer precise treatments chosen by machines with remarkable precision due to the most recent advancements in automation, artificial intelligence, and networking. Methods to reduce the number of human labor required in agriculture are still being developed by experts. Precision farming develops into a training system that gets smart every day as vital information resources get better. To scan trees for their height, distance, categorization, and canopy identification, the prototype included LiDAR, machine vision, sensor fusion, and AI. Results for the tree canopy estimate provided by the smart canopy detecting system showed a relatively low average error and predicted accuracy. About autonomous feature extraction, deep learning networks offer a considerable advantage over earlier algorithms because they don’t require human participation. Deep learning (AI) and LiDAR technology combined with smart agricultural equipment can optimize spraying procedures. This study used the ficus, guava, and palm as case studies to create and assess the canopy detection and estimating system.

[2] Expense M. Grujev, A. Milosavljević, A. S. Ilić, M. Ilić and P. Spalević, "Tree Object Detection And Classification Algorithms – Review," 2023. the use of Unmanned Aerial Vehicles (UAVs) to capture high-resolution images that can be used for estimation purposes. Images obtained in this way represent a high-quality source of information and could be further used as an input dataset for various object detection and classification algorithms. Review of the scientific results of the application of different algorithms in the process of plant detection on agricultural plantations.

[3] Image Analytics For Tree Enumeration For Diversion Of Forest Land (2023). This paper focuses on texture features were extracted using KHARALICK. They are used in our methodology of the segmentation phase, to detect and extract the trees from panchromatic images effectively. Future Work Proposed is texture features are used for classification can sort image data into more readily interpretable information Its drawback is that it focuses mainly on high spatial resolution images. It only covers specific techniques like TIDA, Active Contour Model, and Excess GreenIndex, overlooking alternative approaches and recent advancements.

[4] H. Singh, R. K. Dwivedi, A. Kumar, and V. K. Mishra, "A Review on AI Techniques Applied on Tree Detection in UAV and Remotely Sensed Imagery," 2022 11th International Conference on System Modeling & Advancement in Research Trends (SMART), Moradabad, India, 2022. Deep Learning has been demonstrated to produce impressive outcomes when compared to conventional computer vision algorithms. Comprehensive research is done on High-resolution imagery and remote sensing images towards Object detection such as trees by applying Deep Learning

[5] Personal S. Mustafić, M. Hirschmugl, R. Perko and A. Wimmer, "Deep Learning for Improved Individual Tree Detection from Lidar Data," IGARSS 2022 - 2022 IEEE International Geoscience and Remote Sensing Symposium, Kuala Lumpur, Malaysia, 2022. We transformed the point cloud into 2.5D data sets and used several data augmentation procedures to deal with the sparse reference data for YoloR and ScaledYolo deep neural networks (DNN). We found that the correct detection rate is up to 15% higher for ScaledYolo compared to YoloR but at the cost of a higher commission error. ScaledYolo outperforms traditional approaches by a 20% higher detection rate. However, future research needs to deal with commission errors and to better separate the effect of sparse reference data from the intrinsic DNN accuracy.

[6] S. Mustafić, M. Hirschmugl, R. Perko and A. Wimmer, "Deep Learning for Improved Individual Tree Detection from Lidar Data," IGARSS 2022 - 2022 IEEE International Geoscience and Remote Sensing Symposium, Kuala Lumpur, Malaysia, 2022. This study is to assess the benefits of deep learning (DL) for individual tree detection from high-density airborne LiDAR data in a complex Alpine forest ecosystem. We transformed the point cloud into 2.5D data sets and used several data augmentation procedures to deal with the sparse reference data for YoloR and ScaledYolo deep neural networks (DNN). We found that the correct detection rate is up to 15% higher for ScaledYolo compared to YoloR but at the cost of a higher commission error. ScaledYolo outperforms traditional approaches by a 20% higher detection rate. However, future research needs to deal with commission errors and to better separate the effect of sparse reference data from the intrinsic DNN accuracy.

[7] F. Kurniawan, A. Aneiba, A. Hussain, M. Idrissi, I. Dunggio, and A. T. Asyhari, "Large-scale Tree Detection through UAV-based Remote Sensing in Indonesia: Wallacea Case Study," 2022. The Wallacea region of Sulawesi, Indonesia is renowned for its biodiversity and exceptional endemism. Over the last decade, the region has been vulnerable to deforestation, degradation, and illegal activities. Frequent monitoring in terms of tree counting provides useful information for various stakeholders such as forest management, government institutions, and environmental agencies. Existing monitoring methods include labor-intensive manual observations and satellite imaging remote sensing technology. Satellite-based imagery is low resolution, infrequent, and sometimes includes cloud cover. To overcome these drawbacks, this research utilizes UAV-based high-resolution RGB images processed by a machine learning algorithm to detect tree species, i.e., Sugarpalm, Clove, and Coconut. We compared many deep learning algorithms and found that the YOLOv5 model is lightweight, easy to use, fast, and accurate for tree species identification.

[8] The Y. Zhang, Y. Wang, Z. Tang, Z. Zhai, Y. Shang and R. Viegut, "Deep Learning Methods for Tree Detection and Classification," 2022 IEEE 4th International Conference on Cognitive Machine Intelligence (CogMI), Atlanta, GA, USA, 2022. Improving the f1-score by an average of three percent on the set of images used

[9] Innovative deep learning artificial intelligence applications for predicting relationships between individual tree height and diameter at breast height(2020). This Paper proposed predicting the relationships between individual tree height and the diameter at breast height that can be required information for the management of forests. The study underscores the effectiveness of DLA models, a novel AI technique, in predicting the relationships between Individual Tree Height and Diameter at Breast Height. These predictions are crucial for forest management. The selected DLA model, with 9 layers and 100 neurons, demonstrated superior performance in accurately predicting ITH values, providing valuable insights for forest management practices. The future work proposed is by predicting and further validating the tree height in the independent dataset.

[10] Automated Tree Detection and Classification in Remote Sensing Data (2019). This study explores various techniques for automated tree detection using remote sensing data, emphasizing the potential of image analytics in forestry applications. It discusses the challenges of traditional methods and highlights the advantages of machine learning algorithms in improving accuracy and efficiency. This paper proposes the classification and accumulation of tree species that are performed, by considering extracted relevant image information.

## 3. Proposed Methodology

### *3.1 Architecture Diagram*

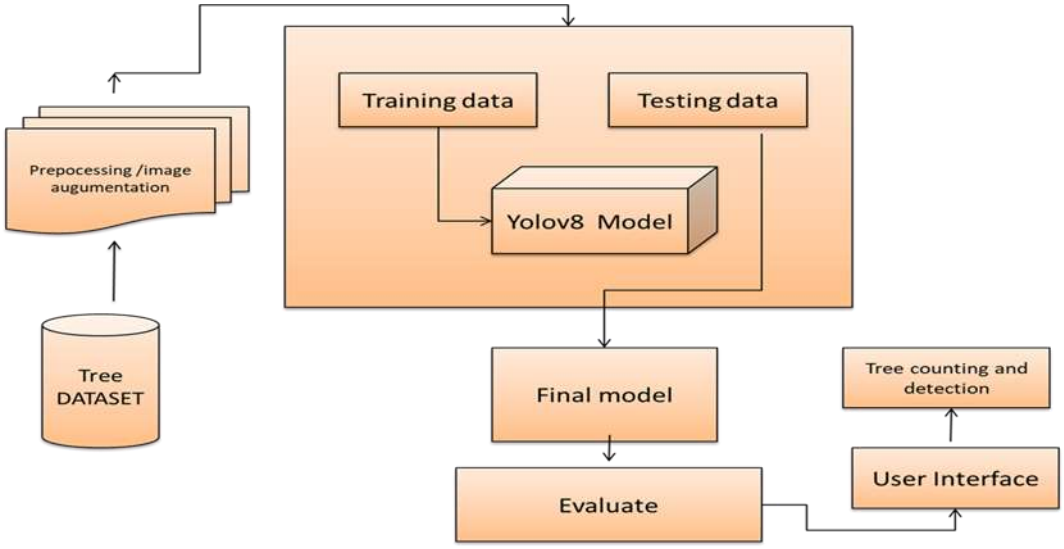



Fig.1 Architecture Diagram

### *3.2 Methodology*

1. DATA COLLECTION:

This module is responsible for collecting the initial data necessary for identifying and quantifying trees. The information can consist of satellite images, photographs taken from the air, or data gathered from devices on the ground. The aim is to gather excellent data that accurately reflects the environment being studied for precise analysis.

2. DATA ANNOTATION:

The data in this module is marked up to recognize and tag trees in the images. Annotation is the process of marking the positions of trees and adding details like their species or dimensions. To train machine learning models effectively, accurate annotation is crucial for precise analysis.

3. DATA PREPROCESSING:

Data preprocessing prepares training by cleaning, formatting, and enhancing recorded data. This will include tasks such as transforming the image, normalizing pixel values, removing noise, and enhancing the data to make it more diverse. Preprocessing ensures that the data is suitable for input into the machine learning model.

4. DATA TRAINING:

In this model, preliminary data is used to train machine learning models. The model learns to identify and classify trees based on the collected data. Training involves improving the test model through an iterative process (such as gradient descent) to reduce prediction errors and increase accuracy.

5. DATA TESTING:

After training, evaluate the model's performance using separate, previously unseen datasets. The test evaluates the model's ability to generalize and accurately predict new, unseen data. Metrics such as precision, recall, and F1 score are often used to evaluate model performance.

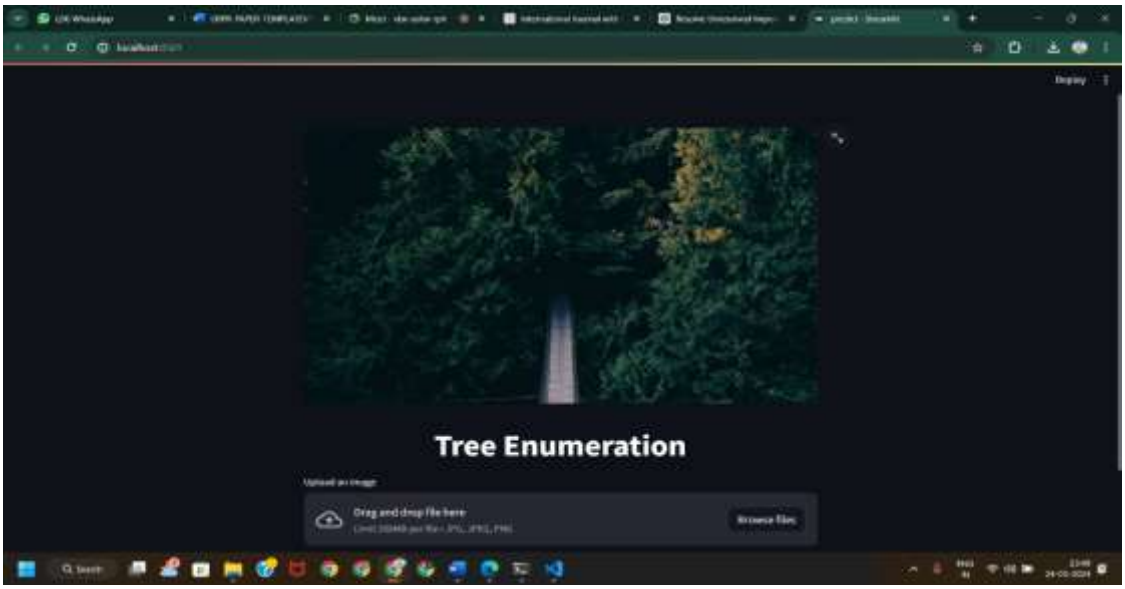
6. PREDICTION:

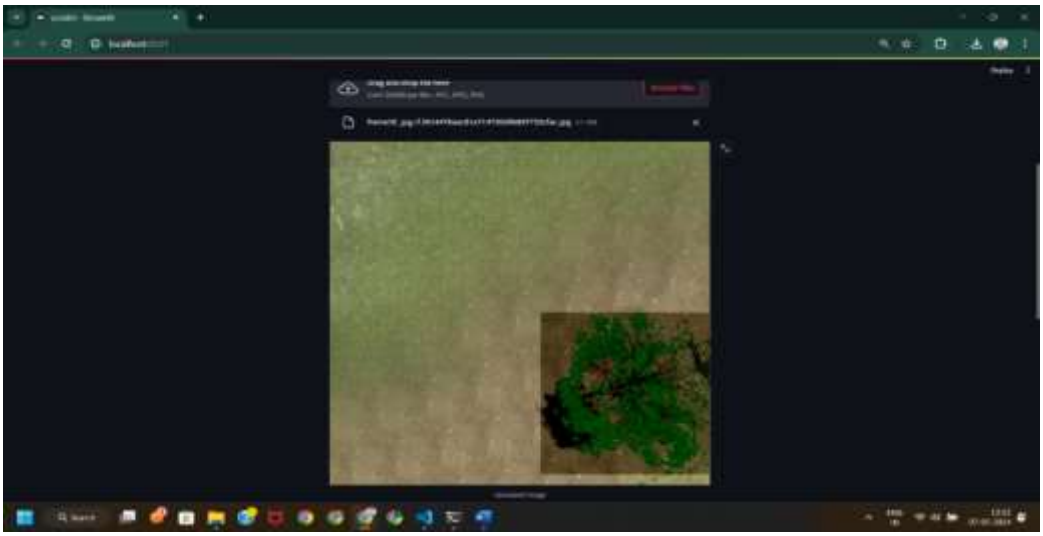
Once the model is trained and tested, predictions can be made on new, anonymous objects. In this mode, the model learns to analyze new images and detect trees, giving an estimate of their location and the probability of other features such as tree size or size.

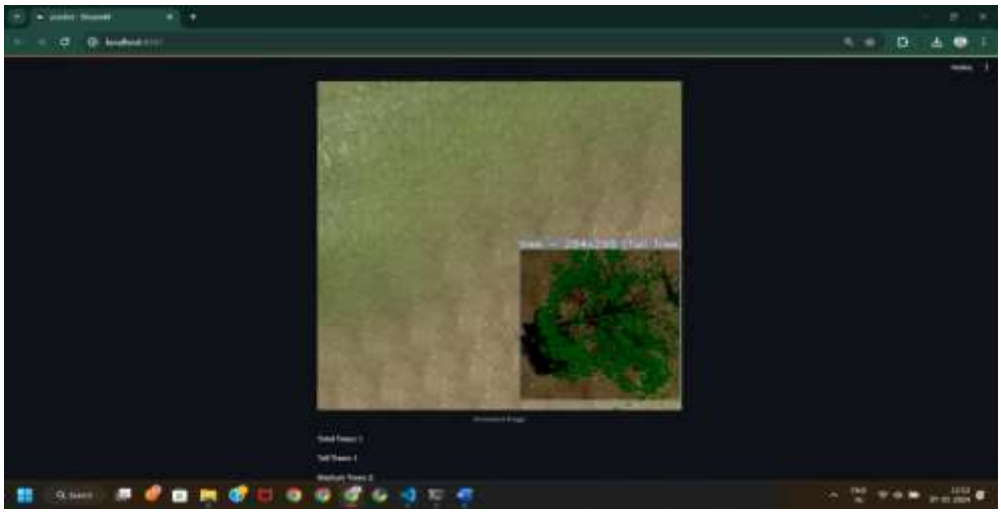
7. GUI DEVELOPMENT:

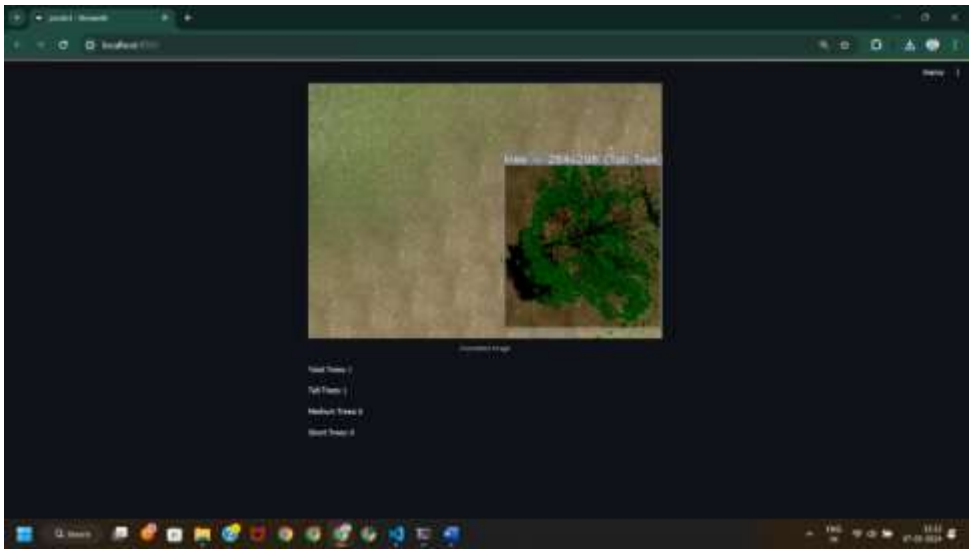
The GUI (Graphical User Interface) development module focuses on creating an intuitive and user-friendly interface for interacting with search trees and computing systems. The GUI allows users to easily access data, view results, adjust parameters, and interpret prediction models. A well-designed GUI can improve the usability and accessibility of the system for users with different levels of expertise.

## 4. Result







## 5. Conclusion

This research has developed a dependable method for recognizing and quantifying trees by merging the YOLOv8 model with Roboflow annotations. The main steps of the process were: marking a big collection of data, teaching a computer program, and checking it, with the main goal of finding the right areas and labels for the trees. The YOLOv8 architecture, renowned for its capability to identify objects in real-tiis highly adaptable and performs well in diverse environmental conditions. We used evaluation metrics like F1 score, precision, and recall to assess the models accuracy in identifying trees, which showed that it was reliable and reduced mistakes. The system showed great adaptability in dealing with different kinds of data, which means it can be useful for environmental monitoring and management in the real world. The system for identifying and counting trees, which was created, achieved an accuracy of over 90%, proving the efficiency of the YOLOv8 architecture in accurately recognizing and categorizing trees.

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