PROJECT REVIEW

STAGE-*II*

PCET'S PIMPRI CHINCHWAD COLLEGE OF

ENGINEERING AND RESEARCH ,Laxmi Nagar,

Ravet, PUNE - 412 101.ACADEMIC YEAR :2023-24

YEAR 2023-24

COMPUTER VISION BASED COTTON HARVESTING ROVER

Under the guidance of
Dr. Rahul.G.Mapari

By

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Introduction

- ***The idea of the project is to develop an advanced cotton picking robot that incorporates computer vision to enhance and upgrade the efficiency and accuracy of cotton harvesting.***

- ***Traditionally cotton picking was done by using methodologies such as hand picking, chemical defoliation, mechanical stripping, manual picking machines etc.***

- ***The challenges faced due to these techniques were labor-intensive work, slow process, inefficiency, involved use of chemicals, constant supervision ,etc.***

- ***Computer vision technology is a revolutionary solution to provide higher efficiency, increased yields and reduced environmental impact.***

- ***OpenCV – Open Source Computer Vision. It is one of the most widely used tools for computer vision and image processing tasks. It is used in various applications such as face detection, video capturing, tracking moving objects, object disclosure.***

- ***Using image processing and open cv the cotton bolls can be detected based on its features and the robotic arm aims to pick them and store it in a container.***

Literature Review

Sr No.	Authors and Year of Publication	Journal Name	Methodology Used	Advantages	Limitations/ Drawbacks
1.	**Author:** Kadeghe Fue **Published:** 30 July 2020	Center-articulated hydrostatic cotton harvesting rover using visual-servoing control and a finite state machine	Development of 4-wheeled center-articulated rover which moves linearly ,vertically and horizontally to pick cotton bolls which were detected by image-based visual servoing using stereo camera.	1.Increased efficiency. 2.Improved accuracy. 3.Reduced labour costs. 4.Increased safety. 5.Scalability.	n real field due to obstruction caused by branches and other leaves it can result in longer picking time. Implementation cost due to hardware, software and maintenance is high.
2.	**Author:** ZHONGJIAN XU **Published:** December 27, 2021	Detecting White Cotton Bolls Using High-Resolution Aerial Imagery Acquired Through Unmanned Aerial System	The methodology used in this research involves image processing techniques to detect white cotton bolls in high-resolution aerial imagery acquired through unmanned aerial systems.	Simple and efficient image processing technique for monitoring agricultural crops, uses high-resolution aerial imagery, good efficiency in distinguishing crops or weeds in high ground rice fields	Detects only white cotton bolls therefore may not be directly applicable to other types of crops or monitoring scenarios. Requires specialized equipment.
3.	**Author:** Edward Barnes **Published:** 28 May 2021	Opportunities for robotic systems and automation in cotton production.	The proposed system uses an autonomous rover equipped with a center-articulated vehicle, an x-y picking manipulator, and a combination vacuum and rotating tines end-effector to pull bolls off the plant.	Cotton production is more profitable for farmers as cotton is picked before the quality is at risk, stereo cameras, RTK-GPS helps in navigating and locating cotton bolls with minimal damage.	Potential challenges faced can be field obstacles, theft, cost, etc. Due to system being autonomous they must require minimal management time.

Literature Review

Sr No.	Authors and Year of Publication	Journal Name	Methodology Used	Advantages	Limitations/ Drawbacks
4.	**Author:** Amanda Issac **Published:** 22 November 2022	Dimensionality Reduction of High-throughput Phenotyping Data in Cotton Fields	This paper involves the use of Principal Component Analysis (PCA) for data reduction in high-throughput phenotyping (HTP) pipelines for cotton fields.	This paper demonstrates the potential of employing machine learning techniques for the data reduction pre-processing step prior to performing subsequent analysis.	Specifies the use case of detecting cotton bloom flowering patterns , and does not specify other use cases. Does not specify the computational requirement and time complexity.
5.	**Author:** Adalberto I. S. Oliveira **Published:** 2019	On the Intelligent Control Design of an Agricultural Mobile Robot for Cotton Crop Monitoring	This system uses a methodology based on the kinematics approach for modelling and control design of a wheeled mobile robot capable of performing autonomous navigation tasks in agricultural fields.	Use of robot which uses differential gear system and can identify cotton bolls exactly from the fields.	This paper specifies only crop monitoring and using a mobile robot whose accuracy is 8/10 use cases.
6.	**Author:** Fue, K. G. **Published:** 2019	VISUAL ROW DETECTION USING PIXEL-BASED ALGORITHM AND STEREO CAMERA FOR COTTON-PICKING ROBOT	Discussion on the cotton production process from pre-planting to harvest and ginning, identifying areas where there is potential for automation, as well as automation applications in other crops that could be adapted to cotton production.	Automated systems could help with weed control, reduce the risk of crop damage due to extreme weather events, and improve the accuracy of harvesting and ginning.	New automated machines will have to match the reliability, self-sufficiency, and economic competitiveness of the existing harvester used in the U.S.

Literature Review

Sr No.	Authors and Year of Publication	Journal Name	Methodology Used	Advantages	Limitations/ Drawbacks
7.	**Author:** Nimkar Amey Sanjay **Published:** 5 July 2021	Cotton harvester through the application of machine learning and image processing techniques.	The machine uses a Camera captures images of the crop, the open cotton bolls are identified in real-time. Information is passed to a microcontroller, which carries out further functions of the bot.	Reduces the collection of trash, reduces the requirement of labor, reduced consumption of fuel and power.	This paper focuses on the development of cotton harvester using machine learning and image processing techniques and not on the practical use.
8.	**Author:** Kadeghe Fue **Published:** July 7–10, 2019	Visual Control of Cotton-picking Rover and Manipulator using a ROS-independent Finite State Machine	The robot is equipped with a ZED stereo camera system that takes images at a rate of 60 frames per second while the rover is stationary. The images are analyzed using OpenCV machine vision algorithms.	Smaller and less expensive. System uses visual controls to pick the bolls, which reduces the risk of damage to the cotton and improves the quality of the harvest	The system was struggling to get a boll if it is located behind the stem or branch. Sometimes it causes the system to leave behind some bolls.
9.	**Author:** Yong Wang **Published:** 2008	MACHINE VISION BASED COTTON RECOGNITION FOR COTTON HARVESTING ROBOT	Uses image acquisition, color analysis and cotton recognition method.	Cost effective, increased scalability, high accuracy.	Requires specific lighting conditions, Does not work well with certain types of cotton.

Gap Identification

From the literature survey following gaps are identified :

- *Obstruction caused due to leaves, branches or other materials can slower the picking time.*
- *Implementation cost due to hardware, software and maintenance.*
- *Autonomous systems must have lesser maintenance time.*
- *Only identifies specific cotton blooming patterns and not specifying other use cases.*
- *Could not identify cotton bolls which were hid behind some branches leaving behind some bolls.*

Problem Statement

COMPUTER VISION

BASED COTTON

HARVESTING ROVER

OBJECTIVES

Objective Complete:

1 . ***To develop an image processing model which accurately identifies cotton bolls amongst other plants.***

Successfully developed a image recognition model which can recognize cotton bolls from its farm environment, the model is developed using a Pretrained YOLO model, Which was again train for a custom dataset of cotton bolls.

2. ***To distinguish mature cotton blooms from pre-matured ones***

Inorder to clearly classify and detect different phases of cotton , the model was trained on 5 classes: cotton
bloom, cotton bud, early boll, matured boll, and split cotton boll.

3. ***To register a design patent for the suggested system and copyright its concept.***

Successfully Filled the copyright , new design for robot arm is developed and the patient process is initiated.

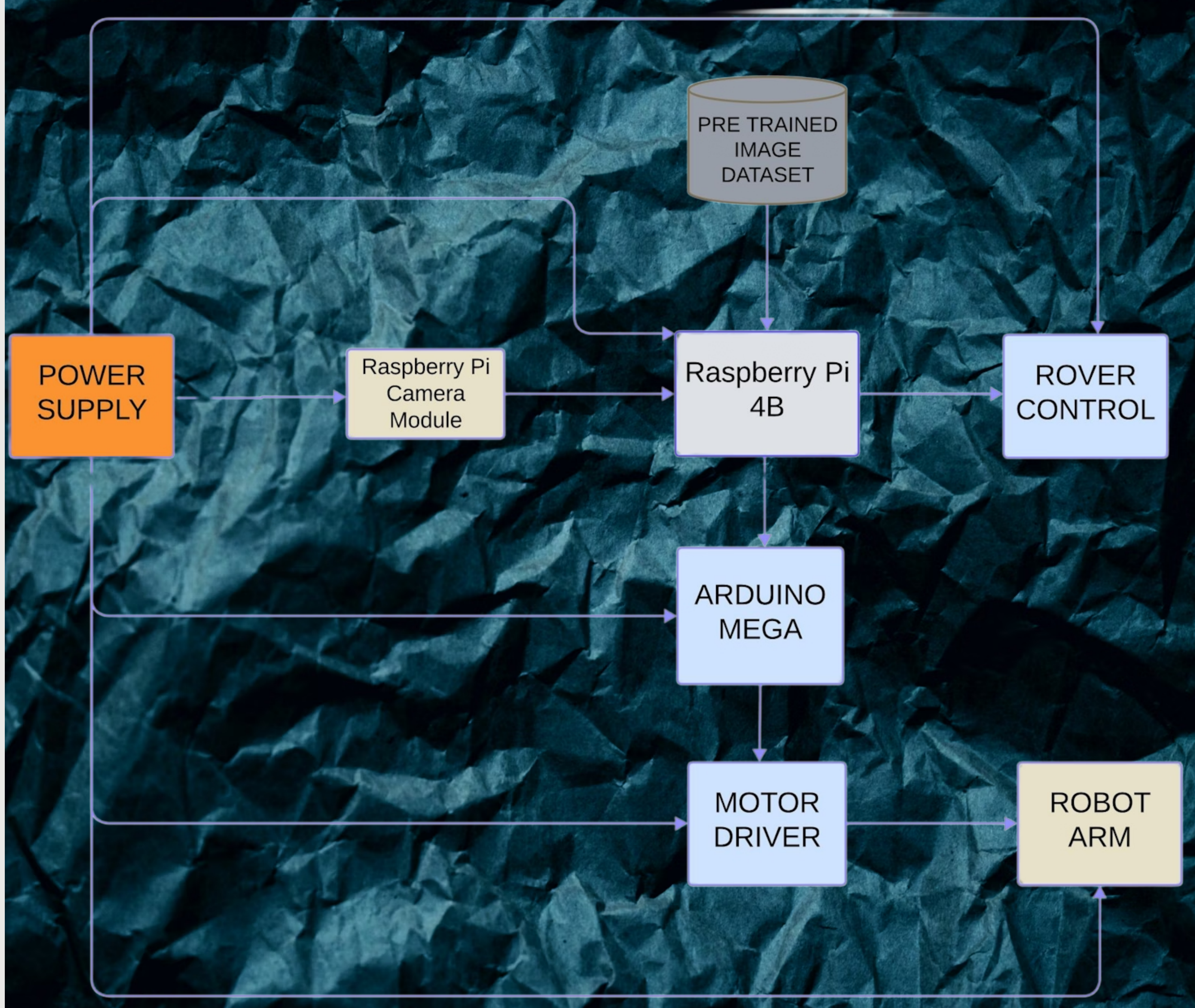
OBJECTIVES

1. *To develop an image processing model which accurately identifies cotton bolls amongst other plants.*
2. *To ensure that plucked cotton bolls are not damaged.*
3. *To distinguish mature cotton blooms from pre-matured ones*
4. *To register a design patent for the suggested system and copyright its concept.*
5. *To ensure that hardware setup and software model are well integrated.*
6. *To guarantee that both manual and autonomous control are possible for the robotic arm.*

PROPOSED METHODOLOGY

Explanation for the block diagram:

1. The most important block of the whole cotton picking robot is its Processor and the computer, which are used for processing and computing the camera feed then sending the command to the robot arm and the rover.
2. The Arm block is integrated with the cotton picking block to remove and collect the cotton bloom from the plants.
3. The Robot motion block is responsible for the system to move in the farm lanes so as to collect the cotton.
4. The Camera block includes the camera on the Rover and the Arm. The camera on the rover is responsible for motion , where as the camera on the arm is responsible for the detection of cotton bloom.



Proposed Methodology: Detection

1.**Data Collection:** Gathered cotton images from various sources; used Roboflow dataset.

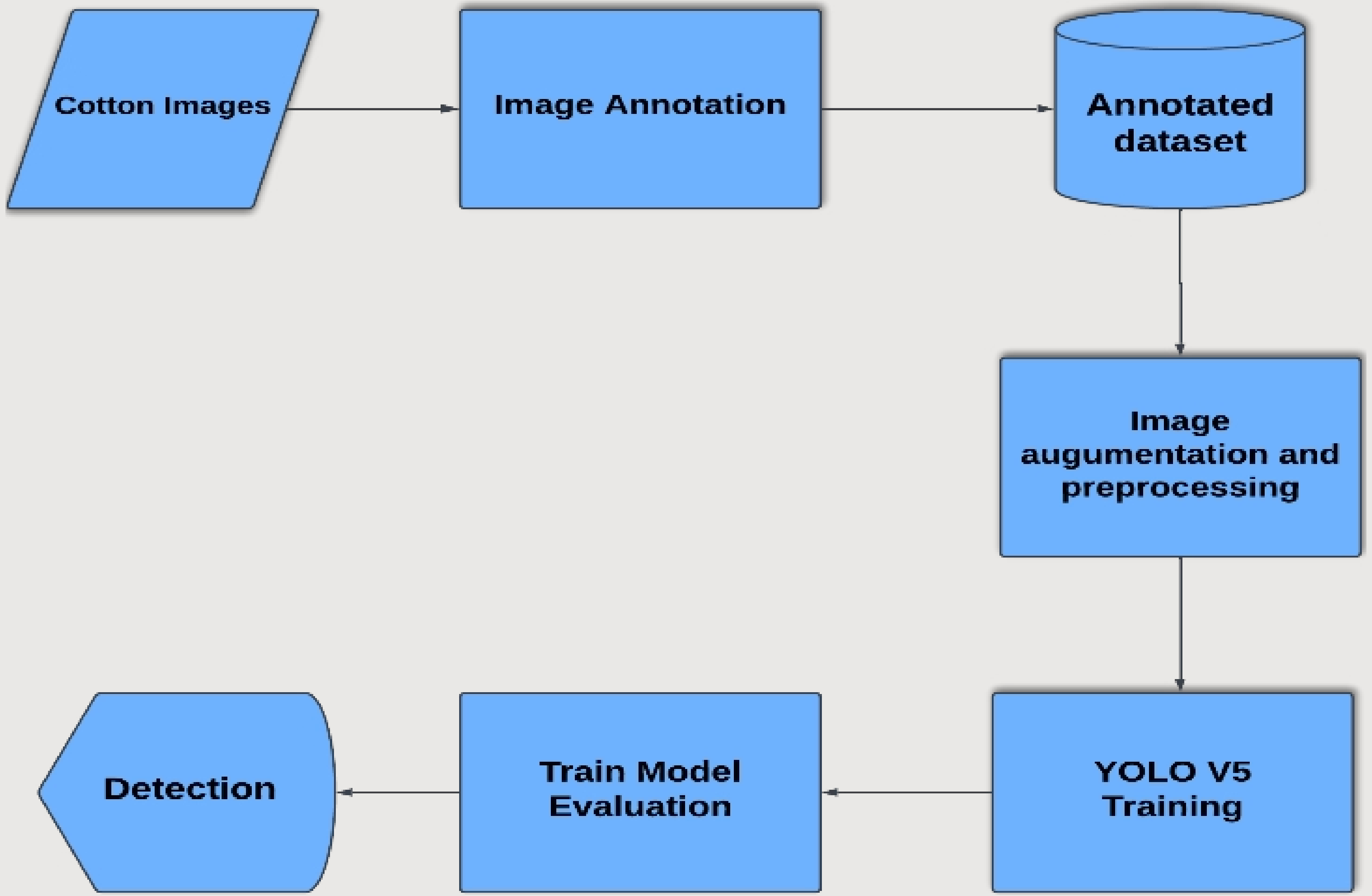
2.**Image Annotation:** Annotated images using tools; created two classes.

3.**Dataset Preparation:** Split into test, validation, and training sets; augmented data.

4.**YOLOv5 Training:** Exported data to Colab; trained model with 150 epochs and batch size of 32; achieved 0.83 accuracy.

5.**Model Evaluation:** Tested on unseen data; evaluated using precision, mAP, and accuracy.

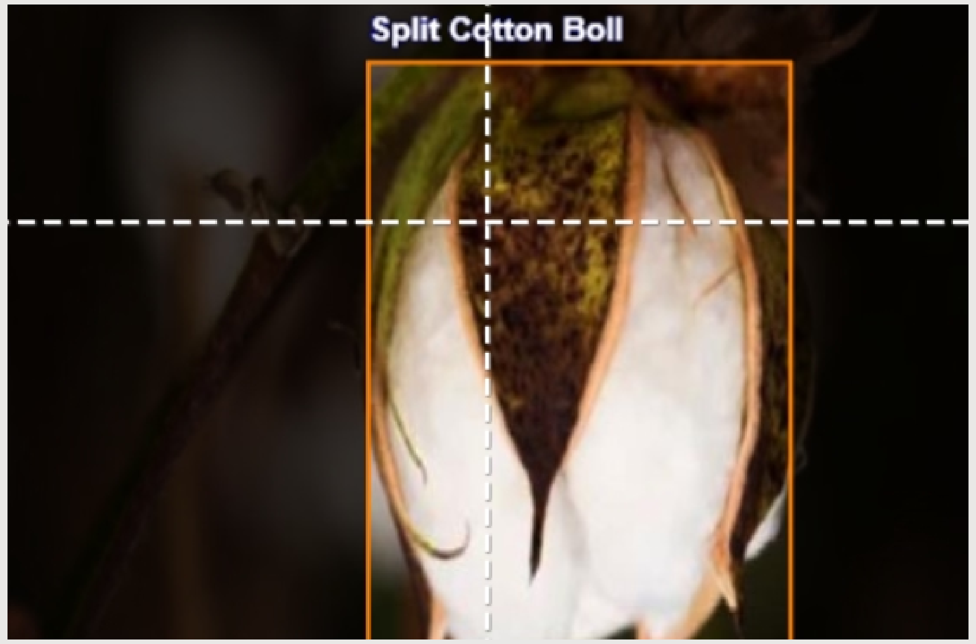
6.**Detection:** Bounding boxes show detected cotton with confidence levels (e.g., 0.8 for 80% confidence).



DATA SET

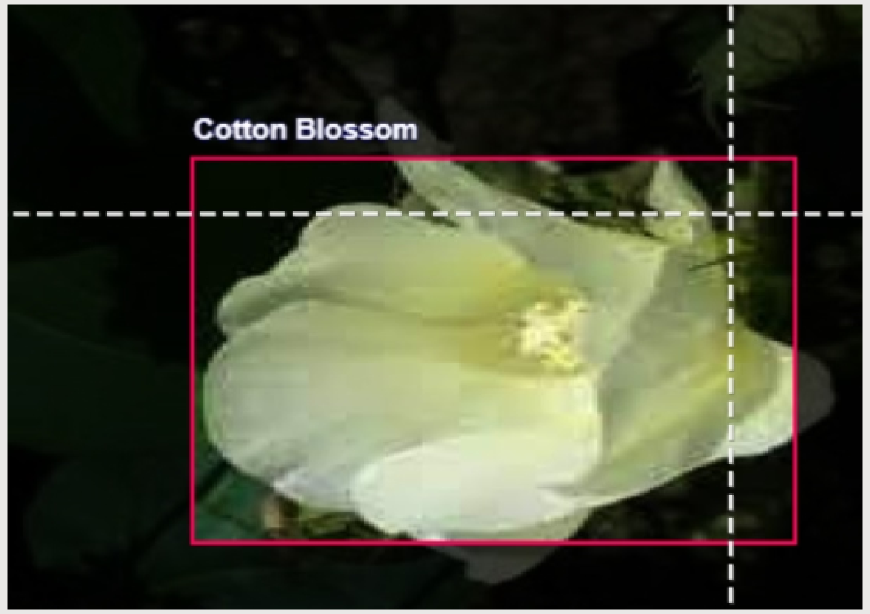
Matured

Cotton Bud



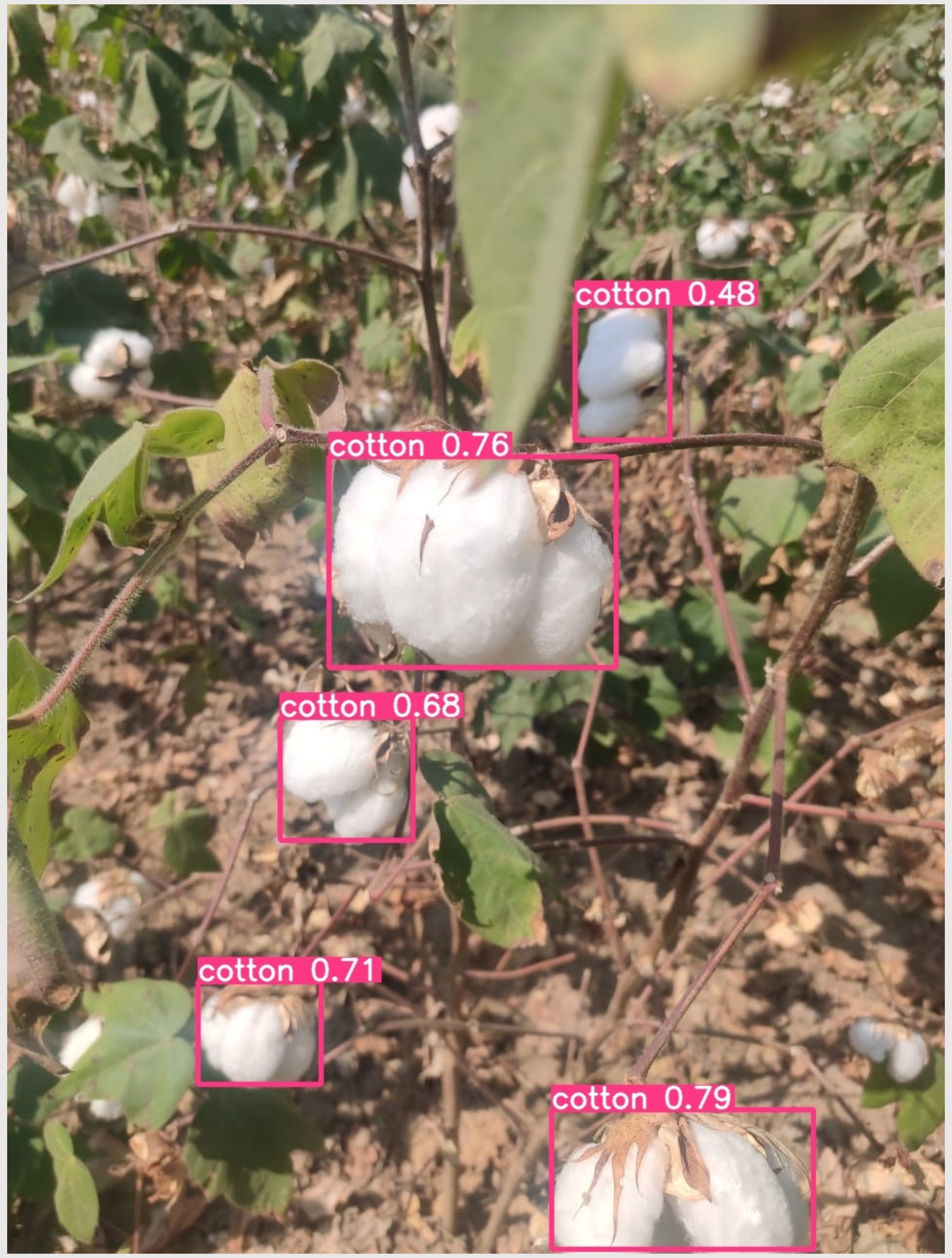
Split Cotton

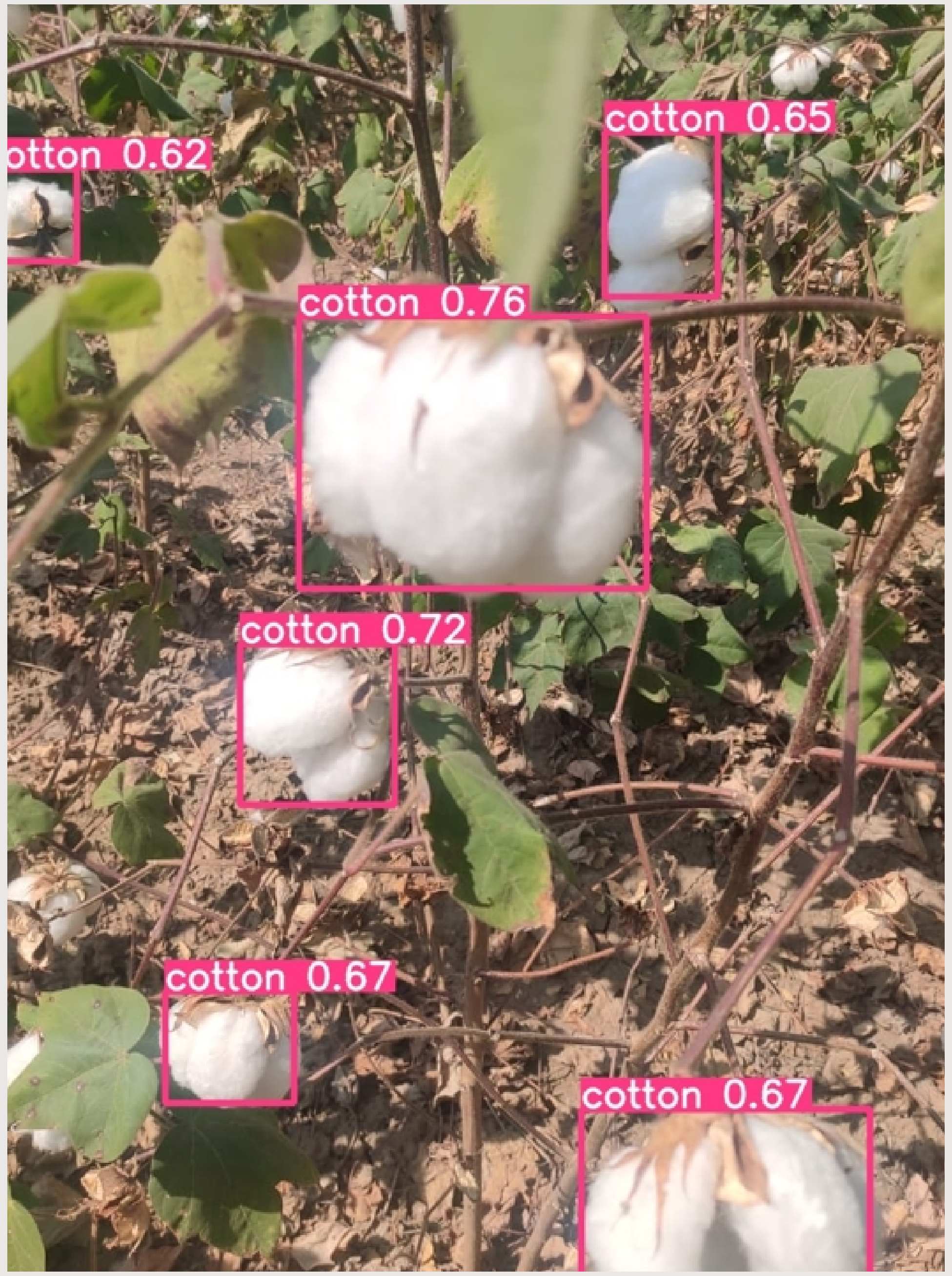
Early boll



Cotton Blossom

Real Time Detection





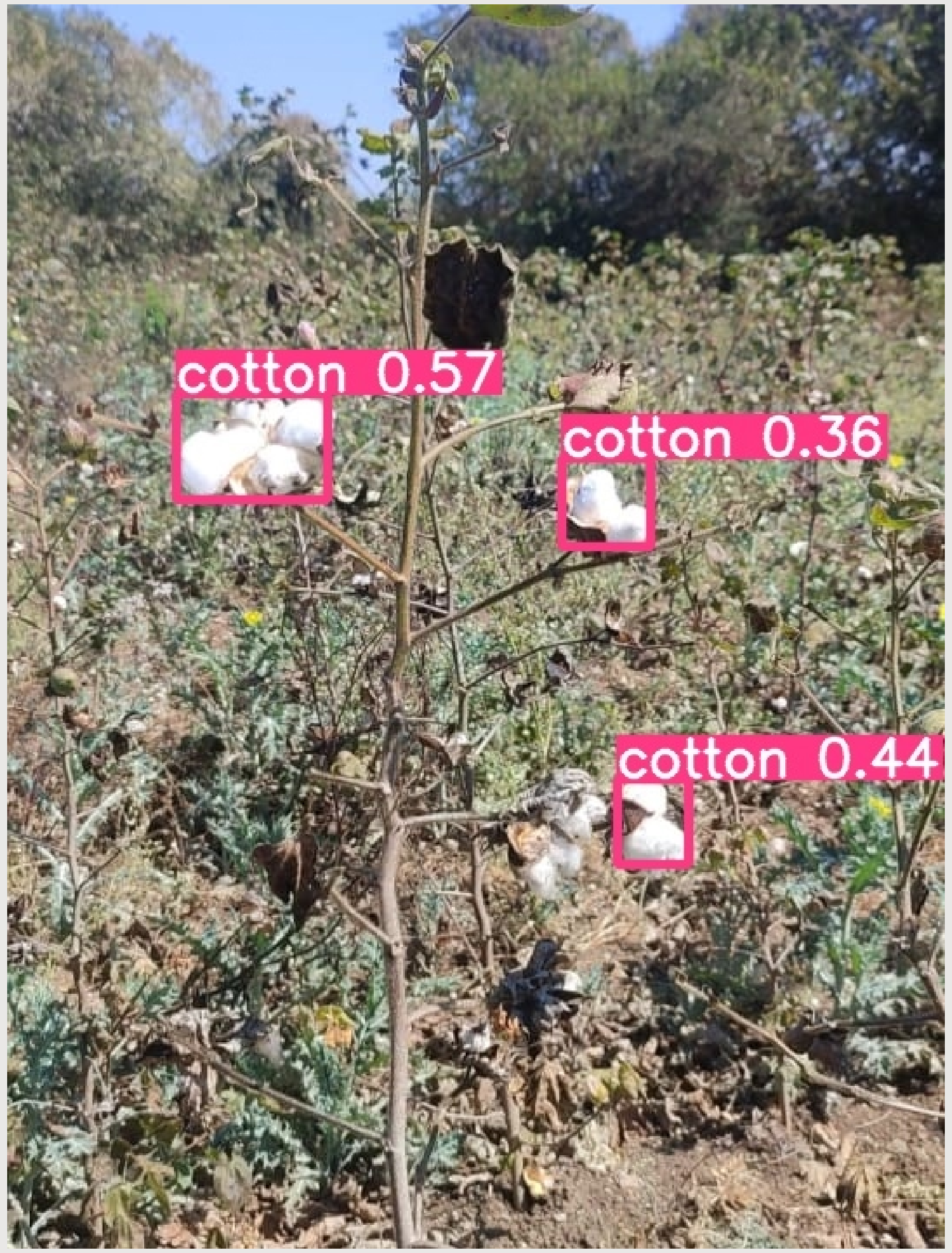


Fig : Detection

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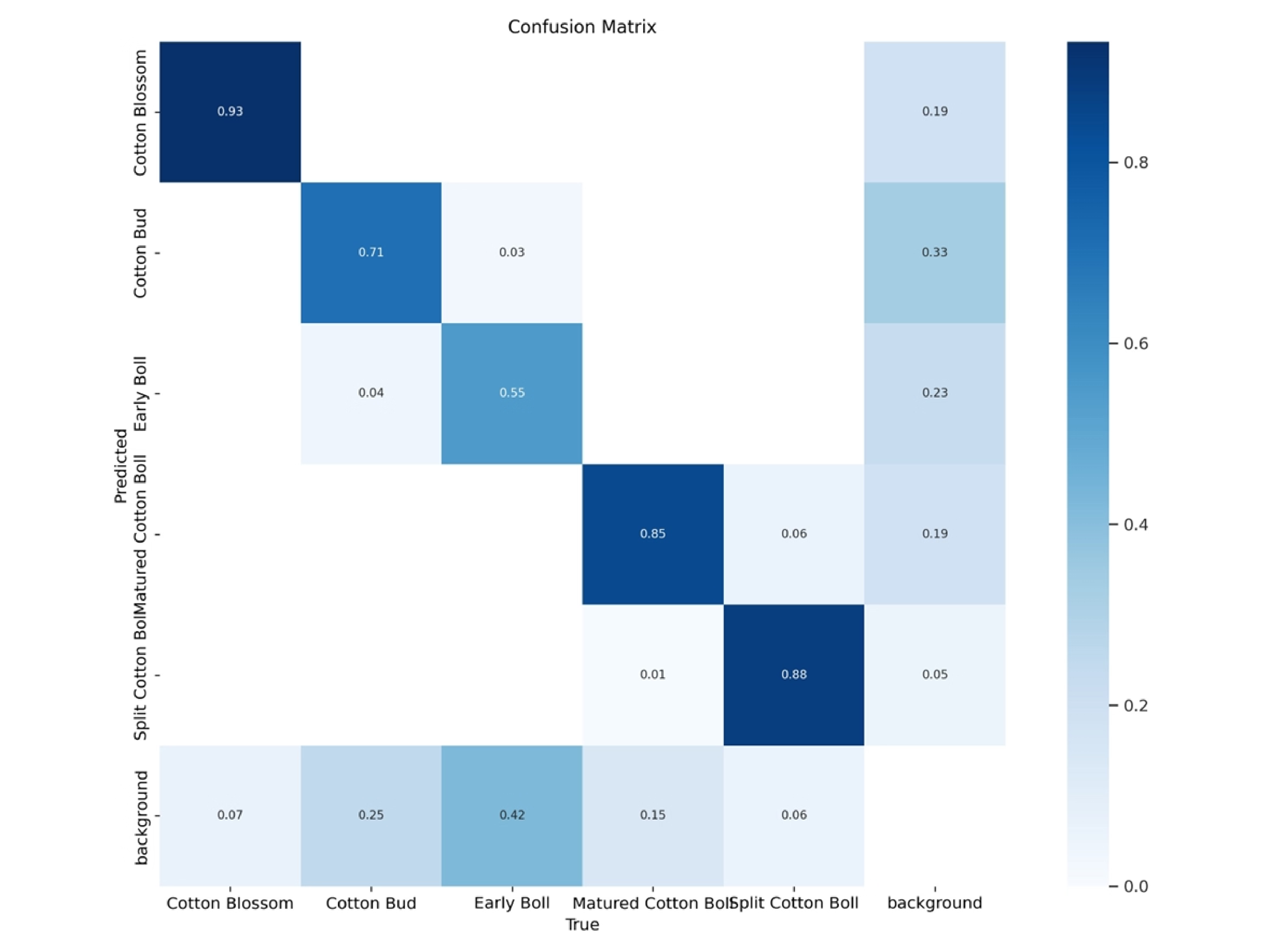
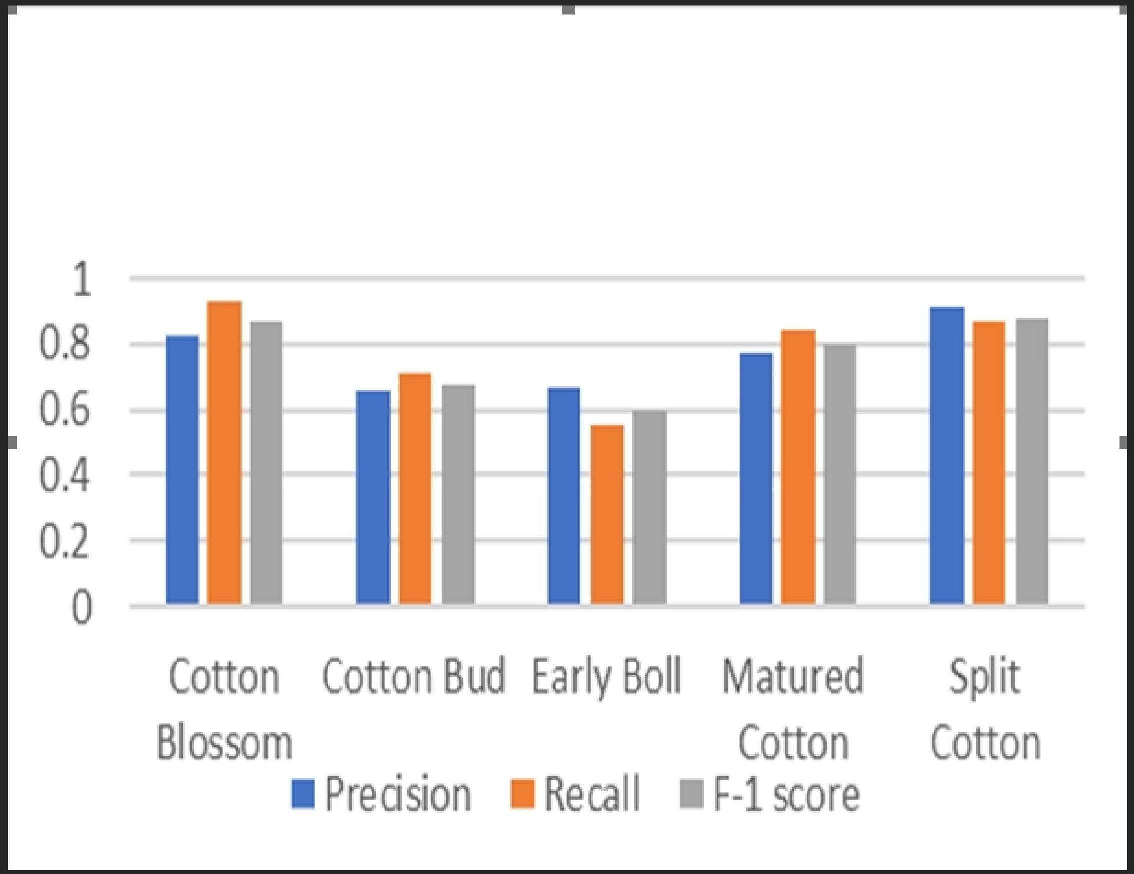
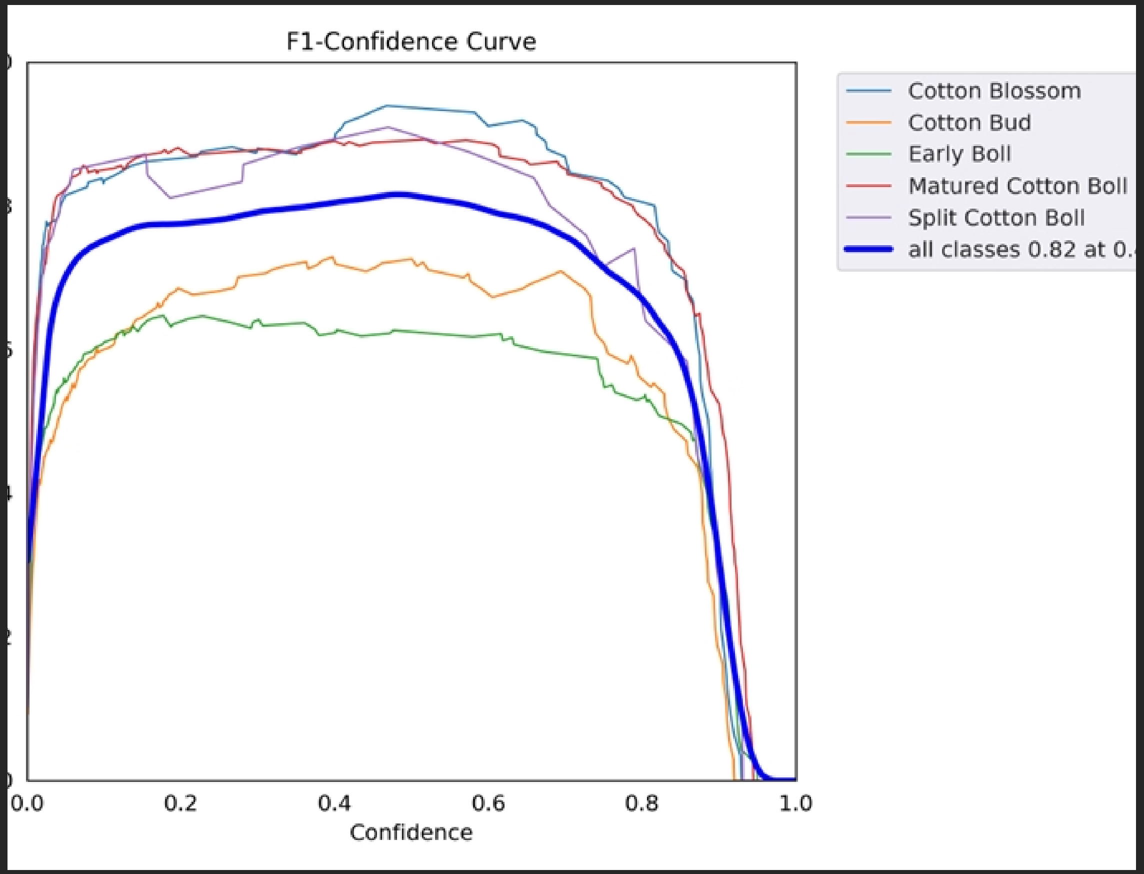
PERFORMANCE METRICS







Algorithm

YOLO v5

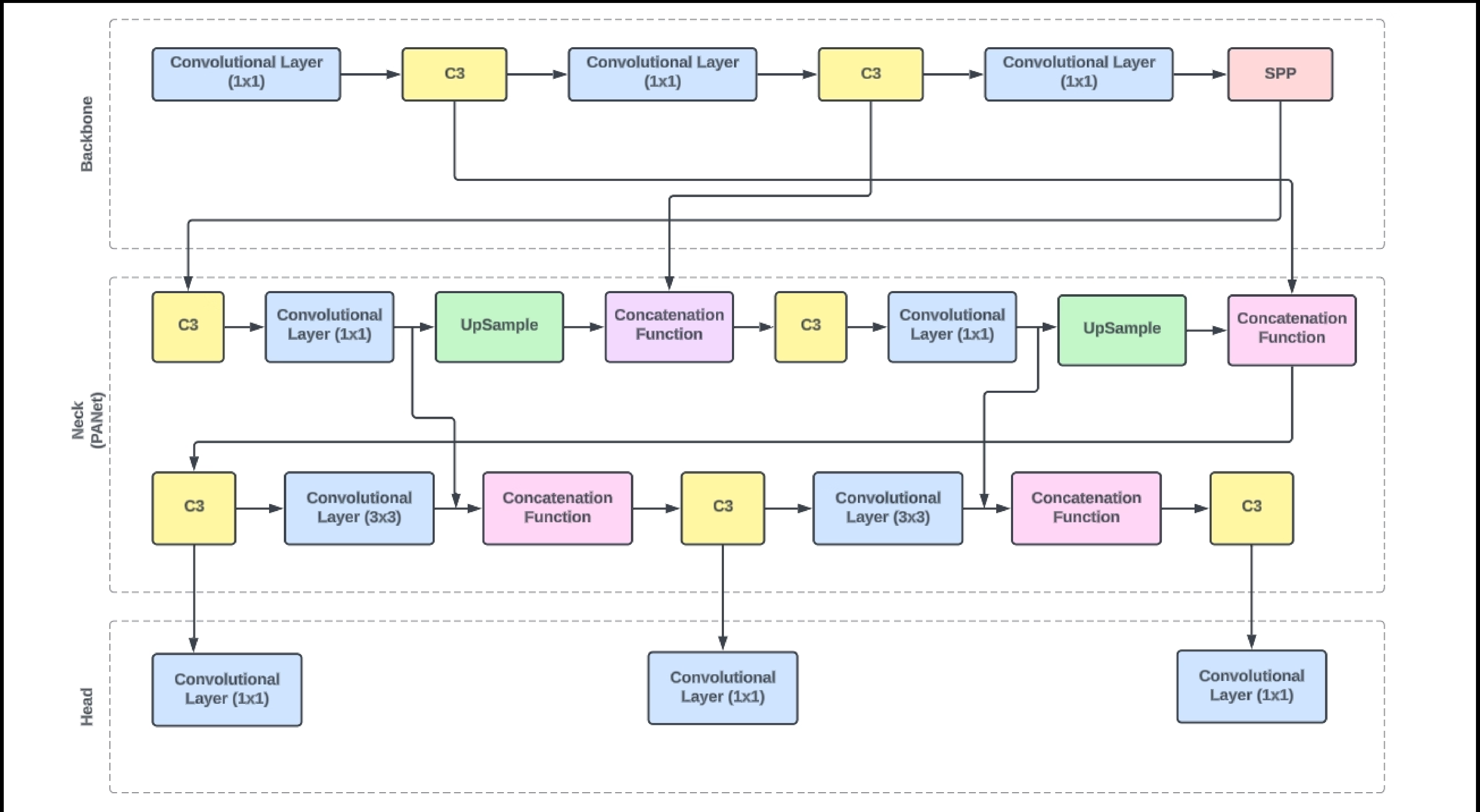
YOLO is an acronym that stands for You Only Look Once. We are employing **Version 5**, which was launched by **Ultralytics** in June 2020 . It is a novel convolutional neural network (CNN) that detects objects in real-time with great accuracy. This approach uses a single neural network to process the entire picture, then separates it into parts and predicts bounding boxes and probabilities for each component. Its architecture mainly consisted of three parts, namely-

- Backbone
- Neck
- Head

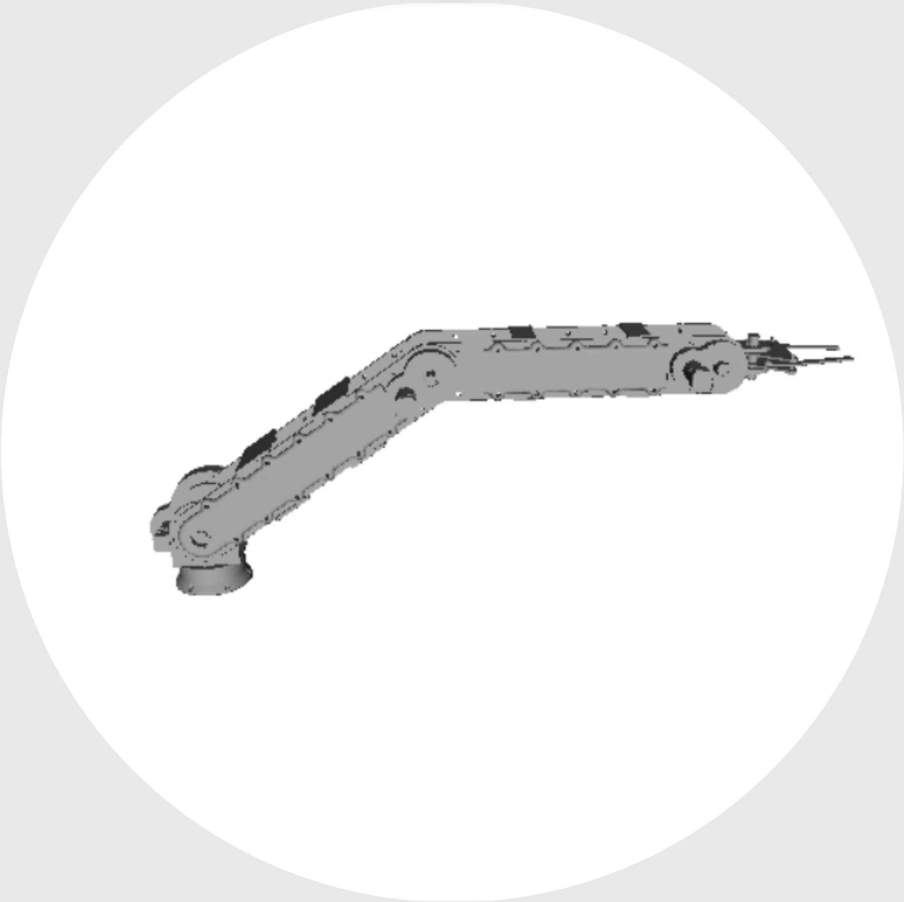
Advantages of YOLO v5:

- It is about 180% faster than YOLOv4 (140 FPS vs 50 FPS)
- It is roughly as accurate as YOLOv4 on the same task (0.895 mAP vs 0.892 mAP)
- It is about 88% smaller than YOLOv4 (27 MB vs 244 MB)

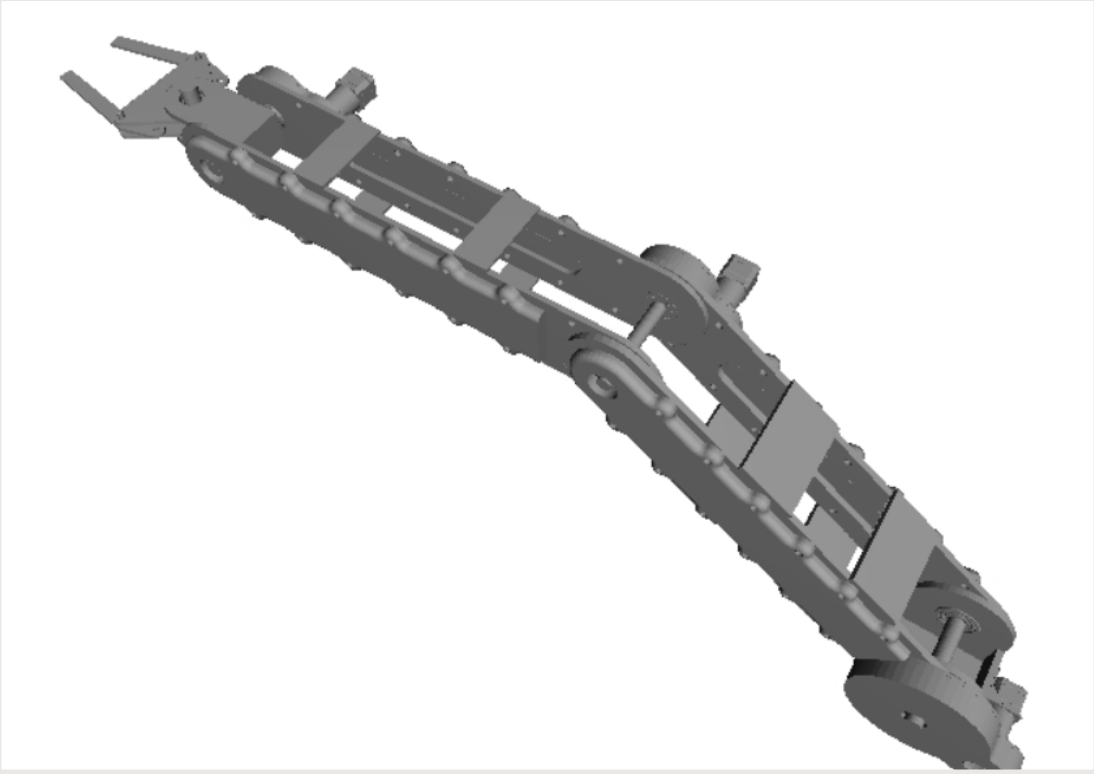
YOLOv5 Architecture



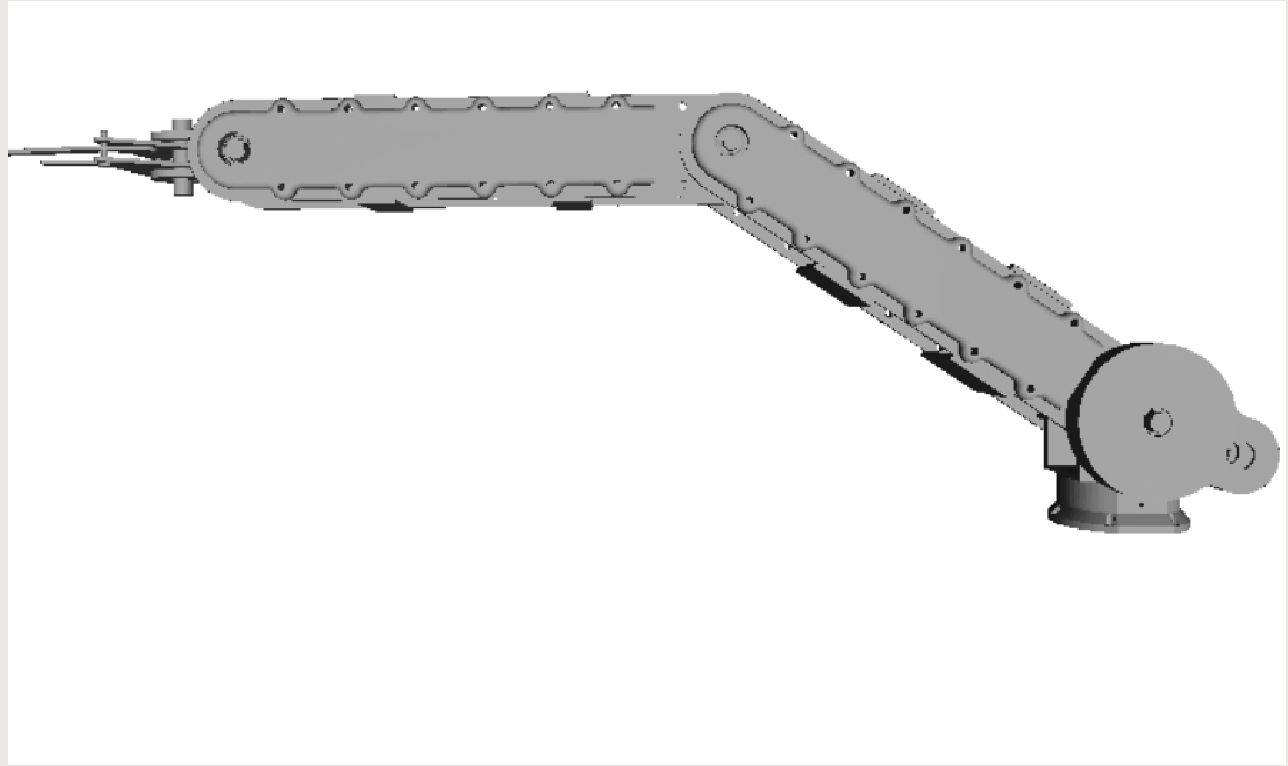
ROBOTIC ARM DESIGN



LEFT SIDE VIEW



TOP VIEW



RIGHT SIDE VIEW

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Advantages

- By using OpenCV, the robot can work autonomously, reducing the need for human intervention and labor costs.
- The real-time image processing capabilities of OpenCV can increase the speed of cotton picking, making the process more efficient.
- OpenCV algorithms can be fine-tuned to improve the accuracy of cotton boll detection, reducing the chances of missing or damaging them during picking
- By reducing the reliance on manual labor, farms are less vulnerable to labor shortages or fluctuations in labor costs.

Expected Conclusion

- Model categorizes cotton bolls into five stages: cotton bloom, cotton bud, early boll, matured boll, and split cotton boll.

- Post-training, the model accurately identified and categorized cotton boll stages.

- Robotic arm intended to execute picking operations but not integrated with the detection model within this project.

- Simulated robotic arm functionality showed precise location and picking task execution.

- Future work: Integrate the robotic arm with the YOLOv5 detection model for an autonomous cotton-picking system.

Research Paper

The following process was undertaken to publish the review paper:

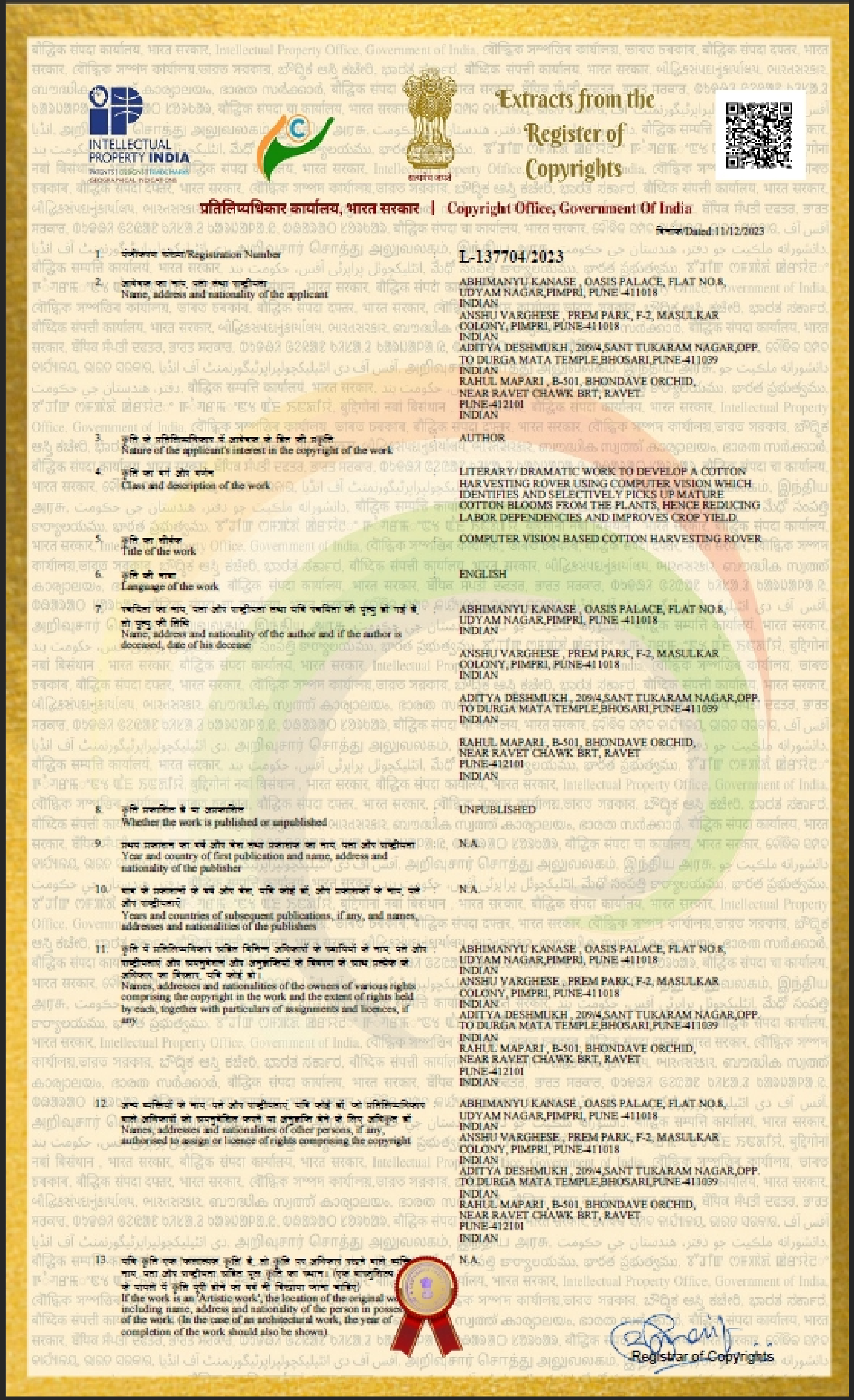
01 **Composing the research paper**
Writing a research paper was started in response to the analysis carried out by looking over each research paper that was relevant to our study. It consisted of the findings from our approach as well as the current and updated methodologies that we employed.

02 **Applying the paper on different conferences**
We applied the paper for various conferences , out of which the paper was selected for 2 conferences.

03 **Selection of the review paper**
After 3 weeks we received an email notifying that the paper was selected on IEEE INCET and Springer.

04 **Registration**
We have registered our paper on their official sites by paying the requested fees. We are waiting for the confirmation of the conference.

05 **Paper Presentation**
Confirmation received and paper was presented on 25th May at IEEE INCET 2024 Conference.



Extracts from the Register of Copyrights

प्रतिलिप्यधिकार कार्यालय, भारत सरकार | Copyright Office, Government Of India

Dated 11/12/2023

1.	Registration Number	L-137704/2023
2.	Name, address and nationality of the applicant	ABHIMANYU KANASE , OASIS PALACE, FLAT NO.8, UDYAM NAGAR,PIMPRI, PUNE -411018 INDIAN ANSHU VARGHESE , PREM PARK, F-2, MASULKAR COLONY, PIMPRI, PUNE-411018 INDIAN ADITYA DESHMUKH , 209/4,SANT TUKARAM NAGAR,OPP. TO DURGA MATA TEMPLE,BHOSARI,PUNE-411039 INDIAN RAHUL MAPARI , B-501, BHONDAVE ORCHID, NEAR RAVET CHAWK BRT, RAVET PUNE-412101 INDIAN
3.	Nature of the applicant's interest in the copyright of the work	AUTHOR
4.	Class and description of the work	LITERARY/ DRAMATIC WORK TO DEVELOP A COTTON HARVESTING ROVER USING COMPUTER VISION WHICH IDENTIFIES AND SELECTIVELY PICKS UP MATURE COTTON BLOOMS FROM THE PLANTS, HENCE REDUCING LABOR DEPENDENCIES AND IMPROVES CROP YIELD.
5.	Title of the work	COMPUTER VISION BASED COTTON HARVESTING ROVER
6.	Language of the work	ENGLISH
7.	Name, address and nationality of the author and if the author is deceased, date of his decease	ABHIMANYU KANASE , OASIS PALACE, FLAT NO.8, UDYAM NAGAR,PIMPRI, PUNE -411018 INDIAN ANSHU VARGHESE , PREM PARK, F-2, MASULKAR COLONY, PIMPRI, PUNE-411018 INDIAN ADITYA DESHMUKH , 209/4,SANT TUKARAM NAGAR,OPP. TO DURGA MATA TEMPLE,BHOSARI,PUNE-411039 INDIAN RAHUL MAPARI , B-501, BHONDAVE ORCHID, NEAR RAVET CHAWK BRT, RAVET PUNE-412101 INDIAN
8.	Whether the work is published or unpublished	UNPUBLISHED
9.	Year and country of first publication and name, address and nationality of the publisher	N.A.
10.	Years and countries of subsequent publications, if any, and names, addresses and nationalities of the publishers	N.A.
11.	Names, addresses and nationalities of the owners of various rights comprising the copyright in the work and the extent of rights held by each, together with particulars of assignments and licences, if any	ABHIMANYU KANASE , OASIS PALACE, FLAT NO.8, UDYAM NAGAR,PIMPRI, PUNE -411018 INDIAN ANSHU VARGHESE , PREM PARK, F-2, MASULKAR COLONY, PIMPRI, PUNE-411018 INDIAN ADITYA DESHMUKH , 209/4,SANT TUKARAM NAGAR,OPP. TO DURGA MATA TEMPLE,BHOSARI,PUNE-411039 INDIAN RAHUL MAPARI , B-501, BHONDAVE ORCHID, NEAR RAVET CHAWK BRT, RAVET PUNE-412101 INDIAN
12.	Names, addresses and nationalities of other persons, if any, authorised to assign or licence of rights comprising the copyright	ABHIMANYU KANASE , OASIS PALACE, FLAT NO.8, UDYAM NAGAR,PIMPRI, PUNE -411018 INDIAN ANSHU VARGHESE , PREM PARK, F-2, MASULKAR COLONY, PIMPRI, PUNE-411018 INDIAN ADITYA DESHMUKH , 209/4,SANT TUKARAM NAGAR,OPP. TO DURGA MATA TEMPLE,BHOSARI,PUNE-411039 INDIAN RAHUL MAPARI , B-501, BHONDAVE ORCHID, NEAR RAVET CHAWK BRT, RAVET PUNE-412101 INDIAN
13.	If the work is an 'Artistic work', the location of the original wo including name, address and nationality of the person in posse of the work. (In the case of an architectural work, the year of completion of the work should also be shown)	N.A.

Registrar of Copyrights

Copyright Certificate

We filed a copyright of the project concept which got accepted.

Try Pitch

Publication Certificate

Jain College of Engineering
Belagavi, India

IEEE BANGALORE SECTION

5th International Conference of Emerging Technology
(INCET 2024)

24th – 26th May 2024

Certificate

This is to certify that Dr./Prof./Mr./Ms. **Anshu Biju Varghese** has presented paper entitled **Cotton Detection Using YOLOv5.** in 5th International Conference of Emerging Technology (INCET 2024) during 24th to 26th May 2024.

Dr. Krupa Rasane
Convener - INCET 2024

Dr. J. Shivakumar
General Chair - INCET 2024

Jain College of Engineering
Belagavi, India

IEEE BANGALORE SECTION

5th International Conference of Emerging Technology
(INCET 2024)

24th – 26th May 2024

Certificate

This is to certify that Dr./Prof./Mr./Ms. **Abhimanyu Rajesh Kanase** has presented paper entitled **Cotton Detection Using YOLOv5.** in 5th International Conference of Emerging Technology (INCET 2024) during 24th to 26th May 2024.

Dr. Krupa Rasane
Convener - INCET 2024

Dr. J. Shivakumar
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Belagavi, India

IEEE BANGALORE SECTION

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Dr. Krupa Rasane
Convener - INCET 2024

Dr. J. Shivakumar
General Chair - INCET 2024

Patent

We successfully filed a patent of the overall process of the project

Welcome Dipali Kedar Shende Sign out

Controller General of Patents, Designs & Trade Marks

सत्यमेव जयते

G.A.R.6
[See Rule 22(1)]
RECEIPT

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PATENTS | DESIGNS | TRADE MARKS
GEOGRAPHICAL INDICATIONS

Docket No 50912

Date/Time 2024/05/26 12:18:59

To
Dipali Kedar Shende

UserId: dipalik

'Safalya', Plot no 27, SR No.32/2k, Near Tambe School, Datta Colony Rahatni Road, Pimpri

CBR Detail:

Sr. No.	App. Number	Ref. No./Application No.	Amount Paid	C.B.R. No.	Form Name	Remarks
1	202421040821	TEMP/E-1/47760/2024-MUM	1600	24705	FORM 1	COMPUTER VISION BASED COTTON PICKING ROVER

TransactionID	Payment Mode	Challan Identification Number	Amount Paid	Head of A/C No
N-0001425082	Online Bank Transfer	2605240002577	1600.00	1475001020000001

Total Amount : ₹ 1600.00
Amount in Words: Rupees One Thousand Six Hundred Only

Received from Dipali Kedar Shende the sum of ₹ 1600.00 on account of Payment of fee for above mentioned Application/Forms.

* This is a computer generated receipt, hence no signature required.

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