FACULTY OF COMPUTING

STATUS DOCUMENT 2

"TeaBot" – Tea Plantation Preservation Using an Intelligent Robot.

STUDENT NAME: PREMATHILAKE H.T.M.

STUDENT NUMBER: IT20265410

GROUP ID: 2023-044

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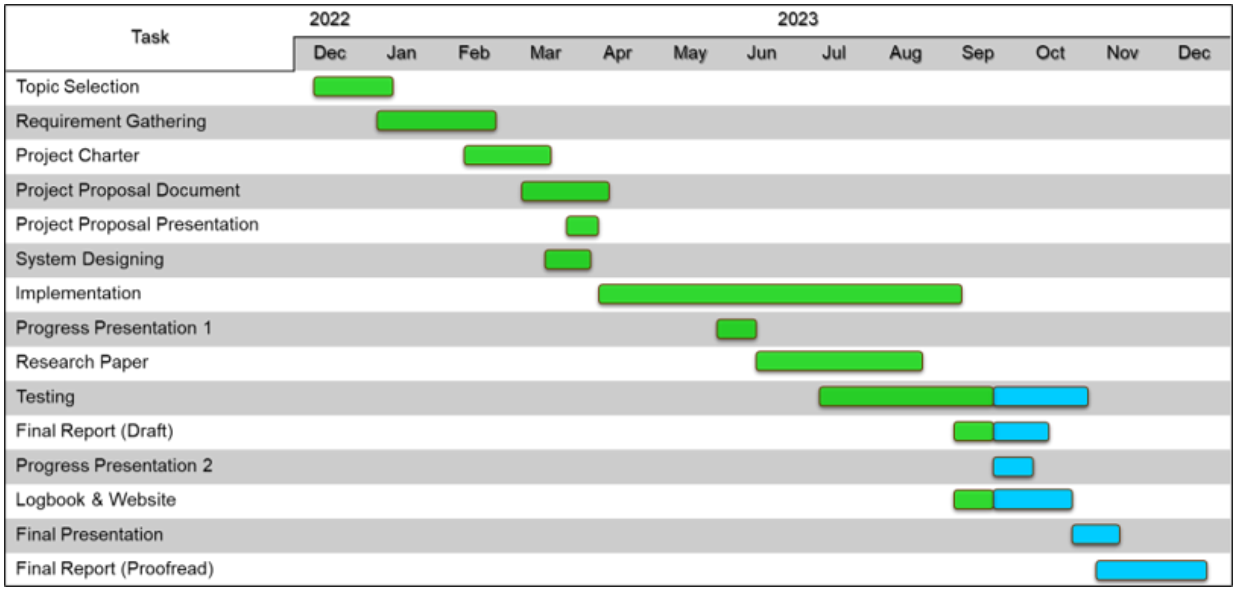
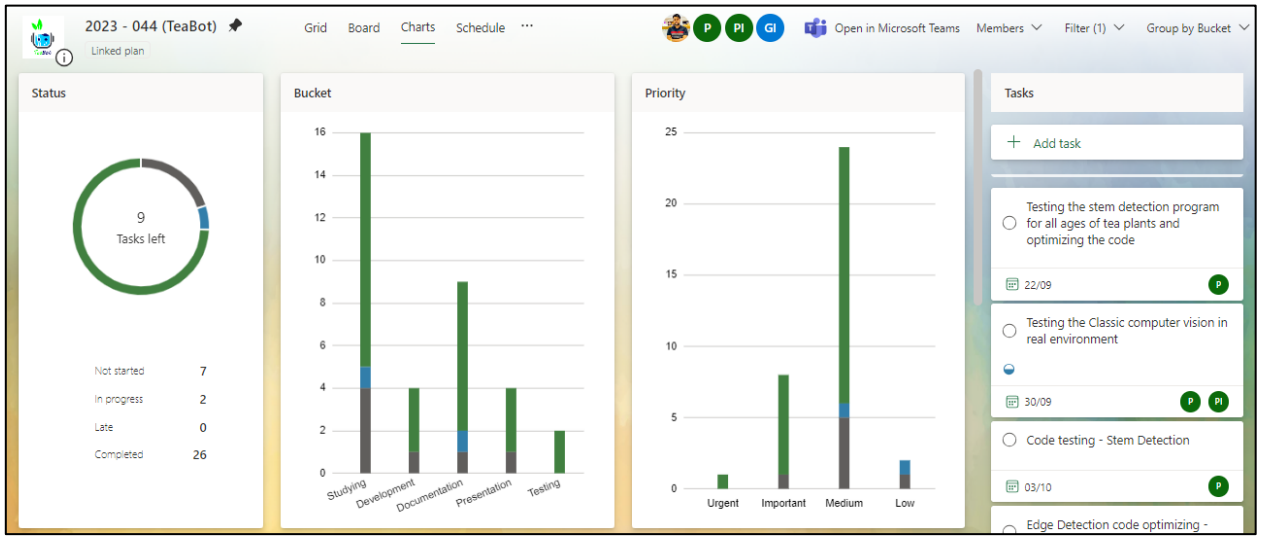
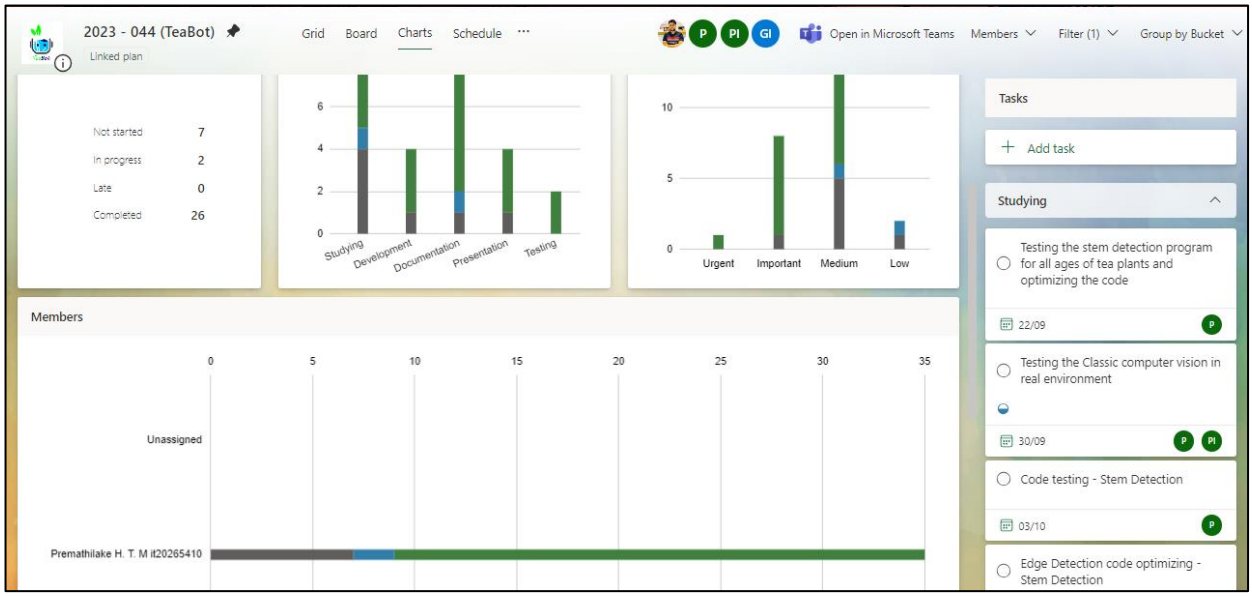
1 GANNT CHART

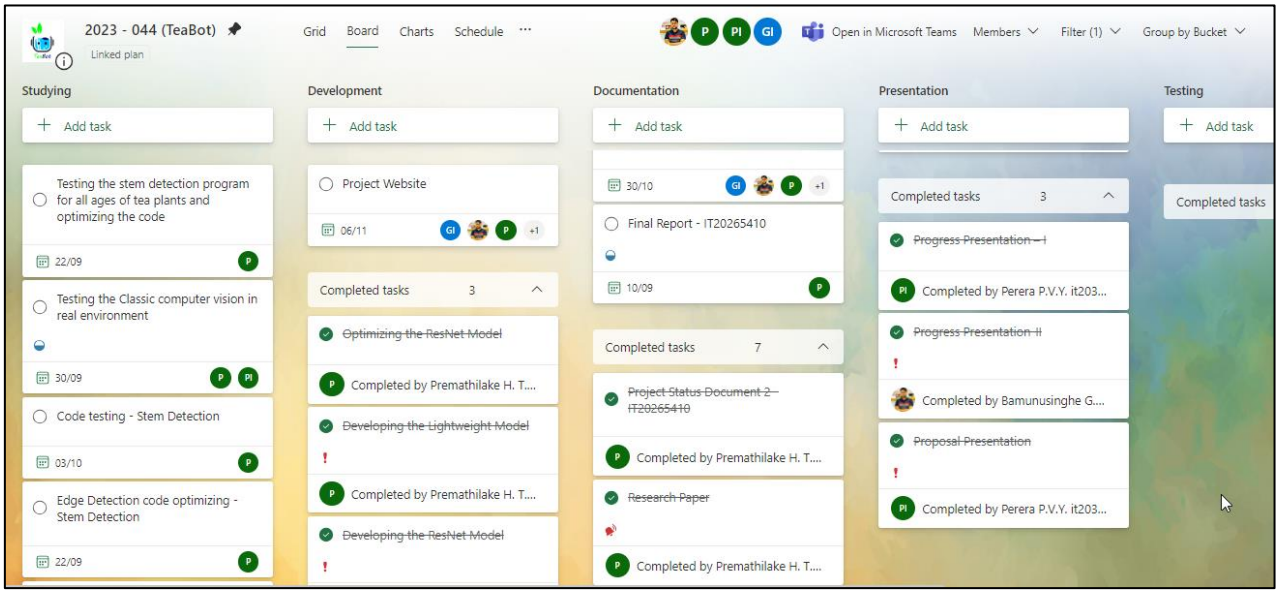


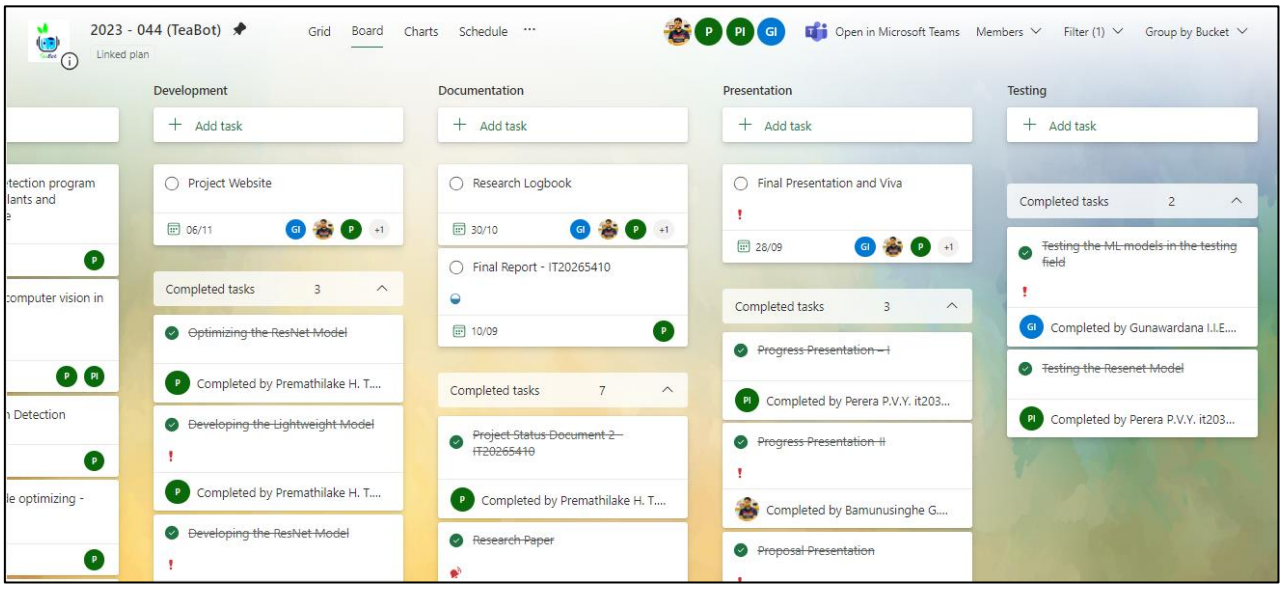
2 PROJECT VIEWS MS PLANNER



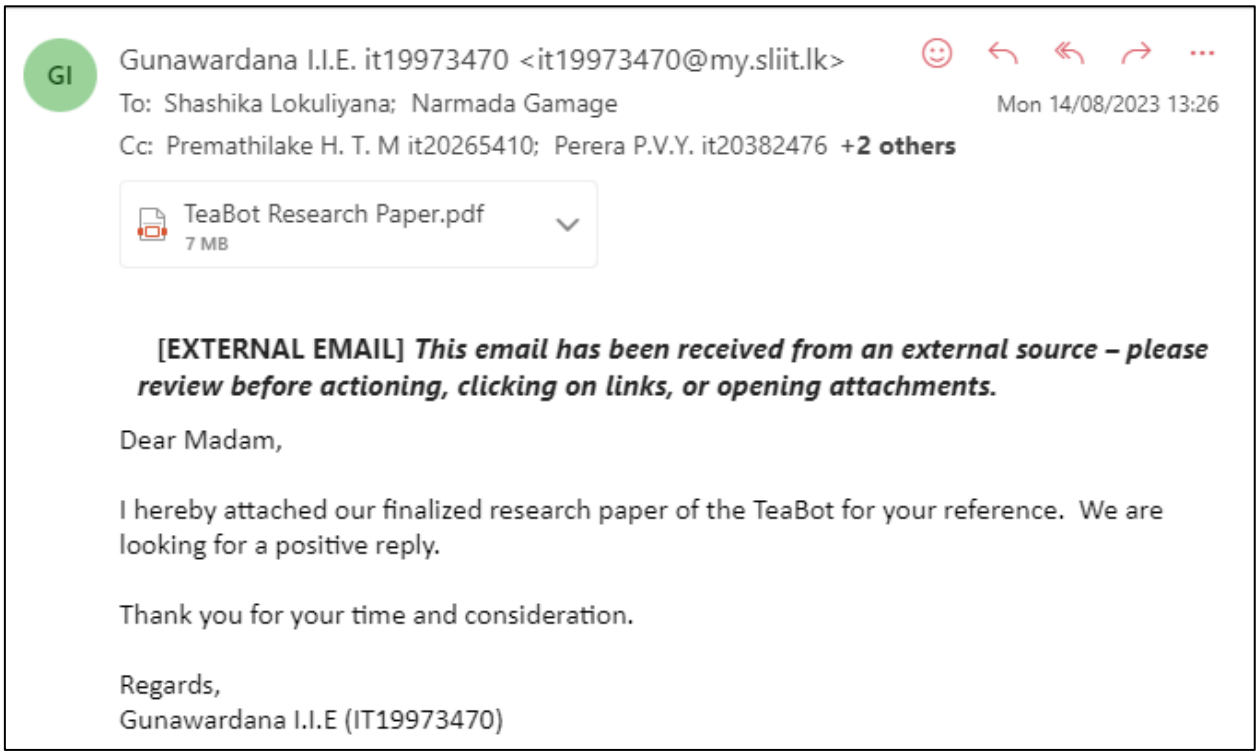


3 Work Break Down Structure Ms Planner





4 EMAILS, MEETINGS WITH SUPERVISOR, CO-SUPERVISOR



GI

Gunawardana I.I.E. it19973470 <it19973470@my.sliit.lk>

To: Shashika Lokuliyana; Narmada Gamage

Mon 14/08/2023 13:26

Cc: Prematthilake H. T. M it20265410; Perera P.V.Y. it20382476 **+2 others**

TeaBot Research Paper.pdf
7 MB

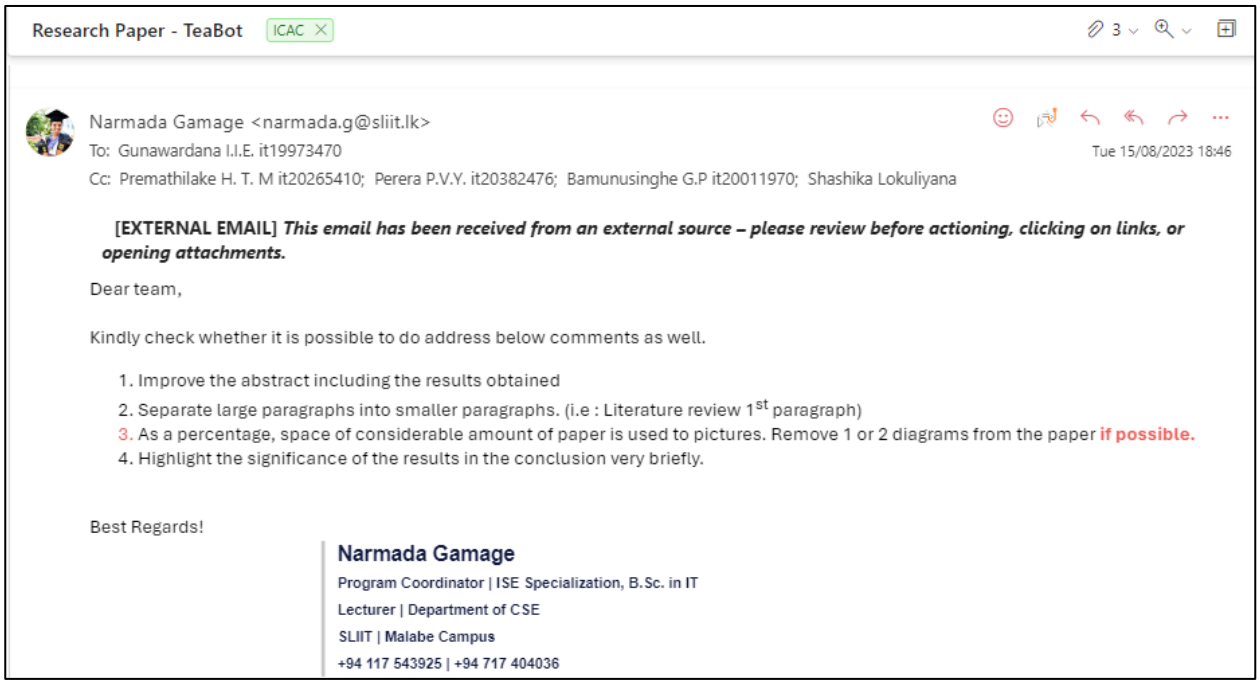
[EXTERNAL EMAIL] ***This email has been received from an external source – please review before actioning, clicking on links, or opening attachments.***

Dear Madam,

I hereby attached our finalized research paper of the TeaBot for your reference. We are looking for a positive reply.

Thank you for your time and consideration.

Regards,
Gunawardana I.I.E (IT19973470)



Research Paper - TeaBot ICAC

Narmada Gamage <narmada.g@sliit.lk>

To: Gunawardana I.I.E. it19973470

Tue 15/08/2023 18:46

Cc: Prematthilake H. T. M it20265410; Perera P.V.Y. it20382476; Bamunusinghe G.P it20011970; Shashika Lokuliyana

[EXTERNAL EMAIL] ***This email has been received from an external source – please review before actioning, clicking on links, or opening attachments.***

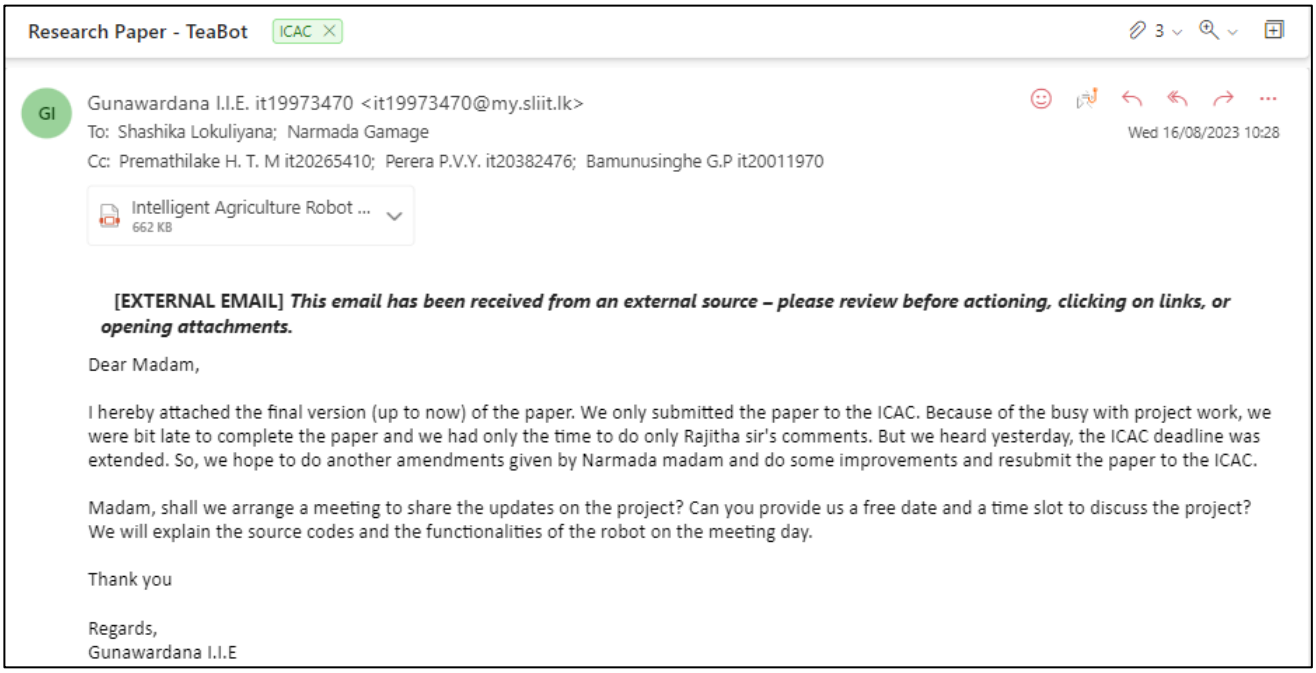
Dear team,

Kindly check whether it is possible to do address below comments as well.

1. Improve the abstract including the results obtained
2. Separate large paragraphs into smaller paragraphs. (i.e : Literature review 1st paragraph)
3. As a percentage, space of considerable amount of paper is used to pictures. Remove 1 or 2 diagrams from the paper **if possible.**
4. Highlight the significance of the results in the conclusion very briefly.

Best Regards!

Narmada Gamage
Program Coordinator | ISE Specialization, B.Sc. in IT
Lecturer | Department of CSE
SLIIT | Malabe Campus
+94 117 543925 | +94 717 404036



Research Paper - TeaBot ICAC

3

GI Gunawardana I.I.E. it19973470 <it19973470@my.sliit.lk>

To: Shashika Lokuliyana; Narmada Gamage

Cc: Premathilake H. T. M it20265410; Perera P.V.Y. it20382476; Bamunusinghe G.P it20011970

Wed 16/08/2023 10:28

Intelligent Agriculture Robot ...
662 KB

[EXTERNAL EMAIL] ***This email has been received from an external source – please review before actioning, clicking on links, or opening attachments.***

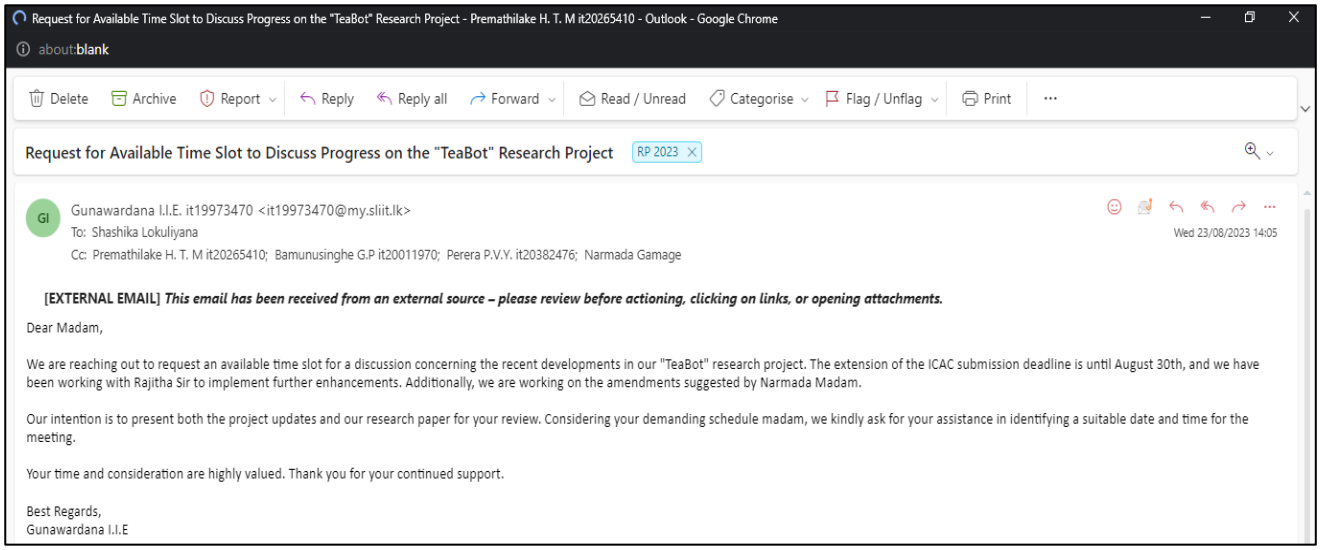
Dear Madam,

I hereby attached the final version (up to now) of the paper. We only submitted the paper to the ICAC. Because of the busy with project work, we were bit late to complete the paper and we had only the time to do only Rajitha sir's comments. But we heard yesterday, the ICAC deadline was extended. So, we hope to do another amendments given by Narmada madam and do some improvements and resubmit the paper to the ICAC.

Madam, shall we arrange a meeting to share the updates on the project? Can you provide us a free date and a time slot to discuss the project? We will explain the source codes and the functionalities of the robot on the meeting day.

Thank you

Regards,
Gunawardana I.I.E



Request for Available Time Slot to Discuss Progress on the "TeaBot" Research Project - Premathilake H. T. M it20265410 - Outlook - Google Chrome

about:blank

Delete Archive Report Reply Reply all Forward Read / Unread Categorise Flag / Unflag Print

Request for Available Time Slot to Discuss Progress on the "TeaBot" Research Project RP 2023

GI Gunawardana I.I.E. it19973470 <it19973470@my.sliit.lk>

To: Shashika Lokuliyana

Cc: Premathilake H. T. M it20265410; Bamunusinghe G.P it20011970; Perera P.V.Y. it20382476; Narmada Gamage

Wed 23/08/2023 14:05

[EXTERNAL EMAIL] ***This email has been received from an external source – please review before actioning, clicking on links, or opening attachments.***

Dear Madam,

We are reaching out to request an available time slot for a discussion concerning the recent developments in our "TeaBot" research project. The extension of the ICAC submission deadline is until August 30th, and we have been working with Rajitha Sir to implement further enhancements. Additionally, we are working on the amendments suggested by Narmada Madam.

Our intention is to present both the project updates and our research paper for your review. Considering your demanding schedule madam, we kindly ask for your assistance in identifying a suitable date and time for the meeting.

Your time and consideration are highly valued. Thank you for your continued support.

Best Regards,
Gunawardana I.I.E

Request for Vehicle Access for PP2 - TeaBot RP 2023

P

Premathilake H. T. M it20265410

To: Shashika Lokuliyana

Fri 01/09/2023 13:29

Cc: Gunawardana I.I.E. it19973470; Perera P.V.Y. it20382476; Bamunusinghe G.P it20011970

Dear Madam,

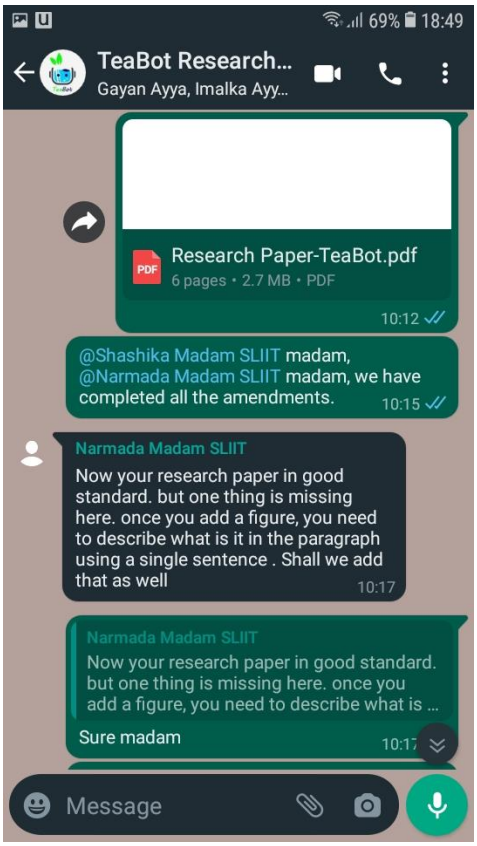
Our PP2 is scheduled for Monday, the 4th, at 12:00 PM. As previously discussed madam, we kindly request permission to bring our vehicle (car), with number '**KA 3522**', in order to transport the robot to SLIIT.

Your continued support and consideration are greatly appreciated.

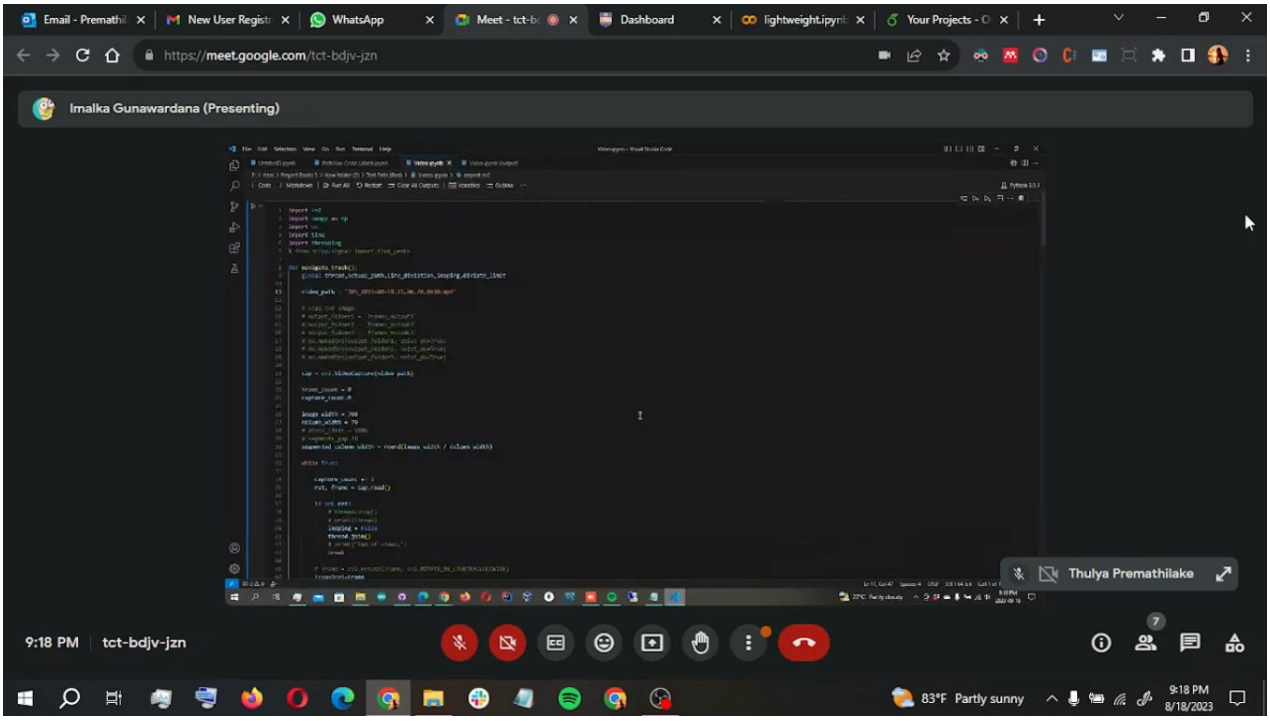
Thank you for your attention to this matter.

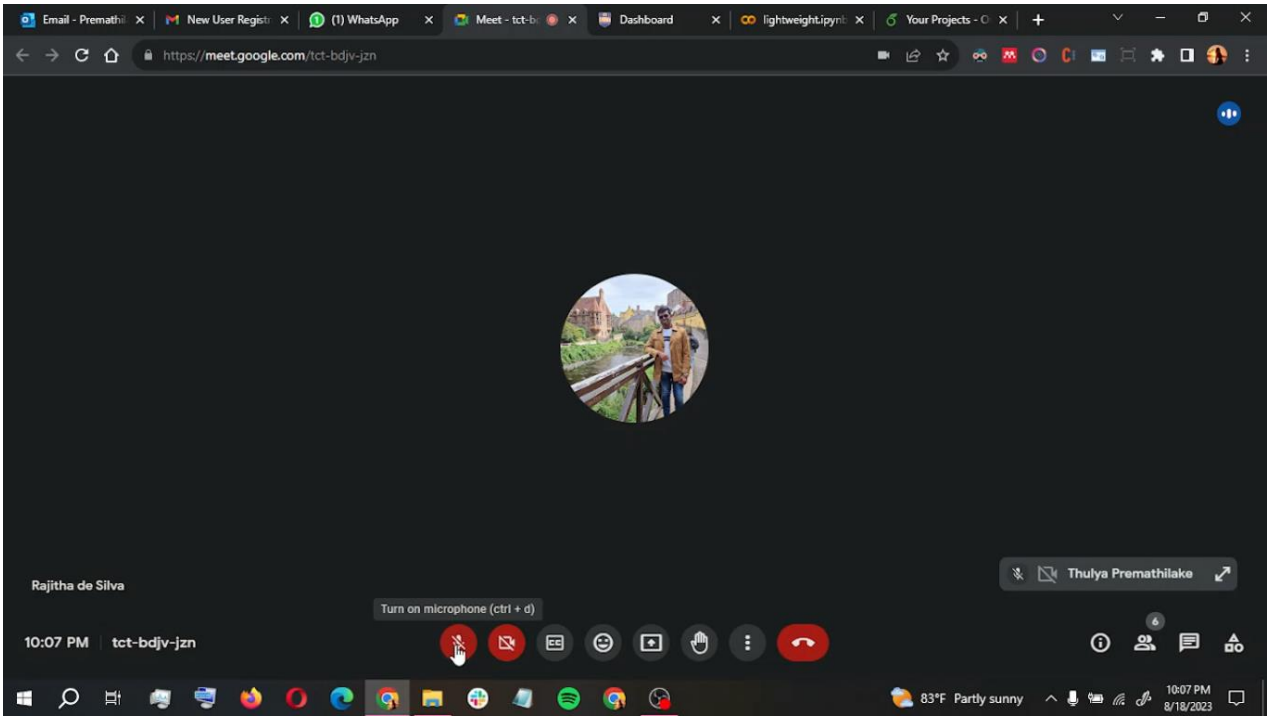
Sincerely,
H.T.M. Premathilake (IT20265410)

WhatsApp conversations with the supervisor and co-supervisor

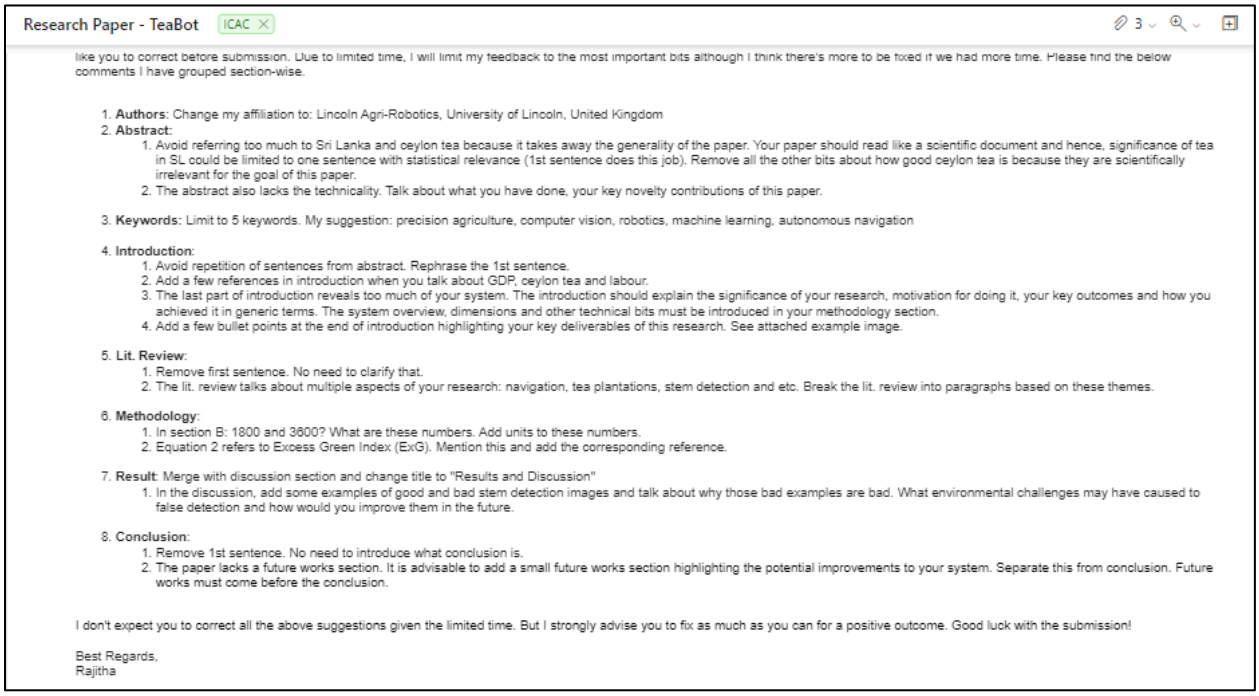


5 EMAILS, MEETINGS WITH EXTERNAL SUPERVISOR





Discussions regarding research paper with external supervisor Dr Rajitha De Silva.



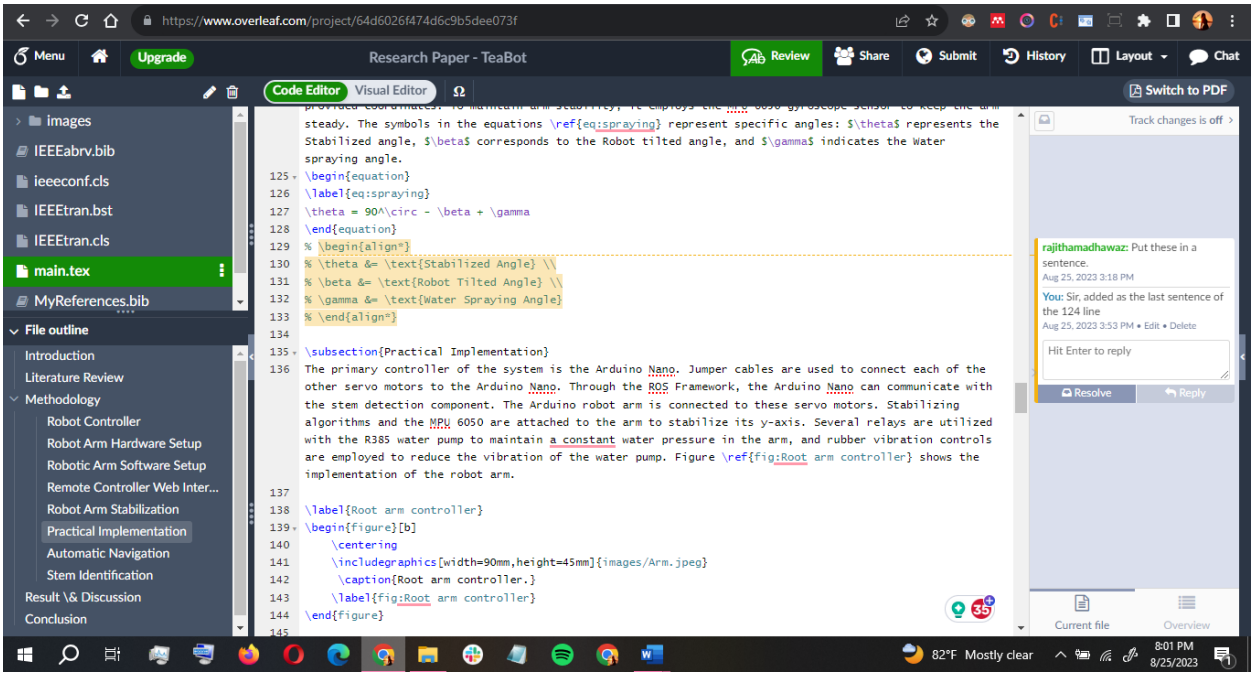
Research Paper - TeaBot ICAC

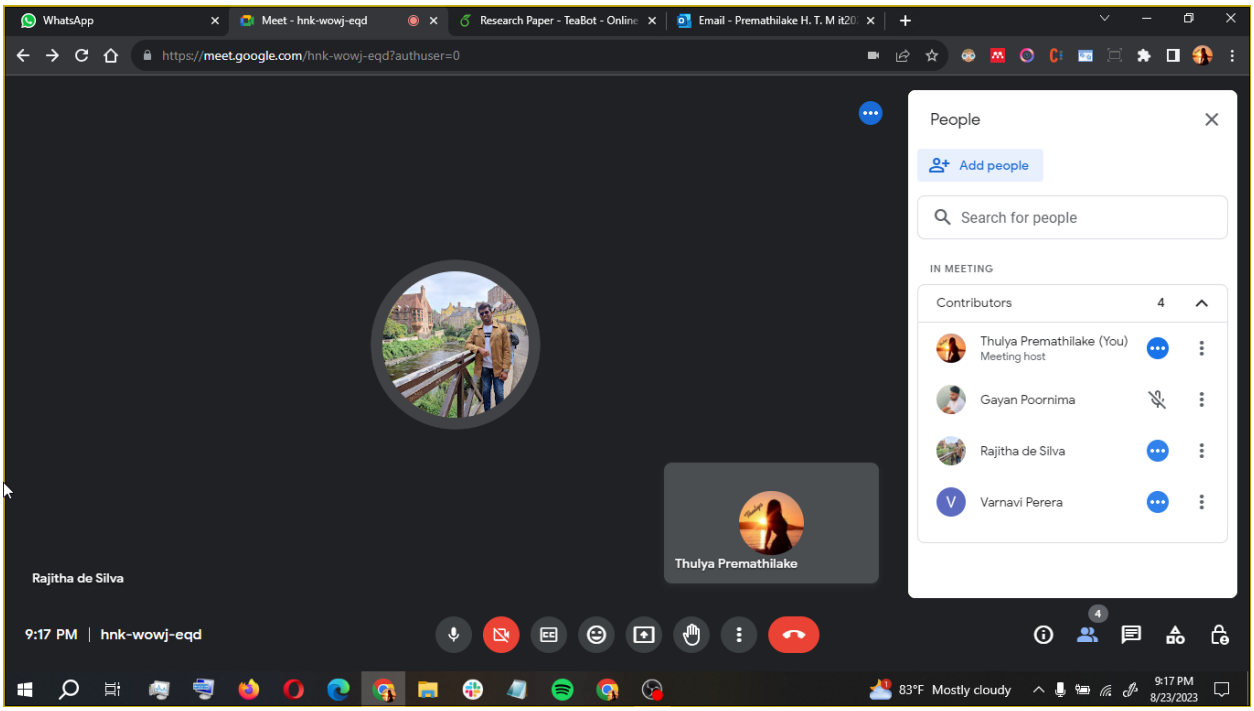
like you to correct before submission. Due to limited time, I will limit my feedback to the most important bits although I think there's more to be fixed if we had more time. Please find the below comments I have grouped section-wise.

1. **Authors**: Change my affiliation to: Lincoln Agri-Robotics, University of Lincoln, United Kingdom
2. **Abstract**:
   1. Avoid referring too much to Sri Lanka and ceylon tea because it takes away the generality of the paper. Your paper should read like a scientific document and hence, significance of tea in SL could be limited to one sentence with statistical relevance (1st sentence does this job). Remove all the other bits about how good ceylon tea is because they are scientifically irrelevant for the goal of this paper.
   2. The abstract also lacks the technicality. Talk about what you have done, your key novelty contributions of this paper.
3. **Keywords**: Limit to 5 keywords. My suggestion: precision agriculture, computer vision, robotics, machine learning, autonomous navigation
4. **Introduction**:
   1. Avoid repetition of sentences from abstract. Rephrase the 1st sentence.
   2. Add a few references in introduction when you talk about GDP, ceylon tea and labour.
   3. The last part of introduction reveals too much of your system. The introduction should explain the significance of your research, motivation for doing it, your key outcomes and how you achieved it in generic terms. The system overview, dimensions and other technical bits must be introduced in your methodology section.
   4. Add a few bullet points at the end of introduction highlighting your key deliverables of this research. See attached example image.
5. **Lit. Review**:
   1. Remove first sentence. No need to clarify that.
   2. The lit. review talks about multiple aspects of your research: navigation, tea plantations, stem detection and etc. Break the lit. review into paragraphs based on these themes.
6. **Methodology**:
   1. In section B: 1800 and 3600? What are these numbers. Add units to these numbers.
   2. Equation 2 refers to Excess Green Index (ExG). Mention this and add the corresponding reference.
7. **Result**: Merge with discussion section and change title to "Results and Discussion"
   1. In the discussion, add some examples of good and bad stem detection images and talk about why those bad examples are bad. What environmental challenges may have caused to false detection and how would you improve them in the future.
8. **Conclusion**:
   1. Remove 1st sentence. No need to introduce what conclusion is.
   2. The paper lacks a future works section. It is advisable to add a small future works section highlighting the potential improvements to your system. Separate this from conclusion. Future works must come before the conclusion.

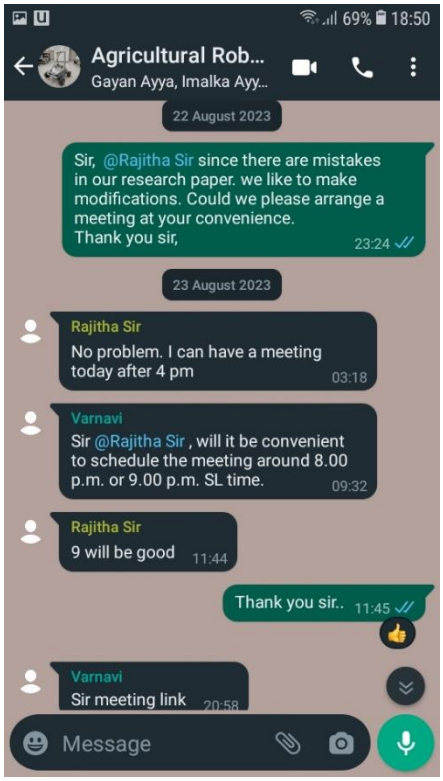
I don't expect you to correct all the above suggestions given the limited time. But I strongly advise you to fix as much as you can for a positive outcome. Good luck with the submission!

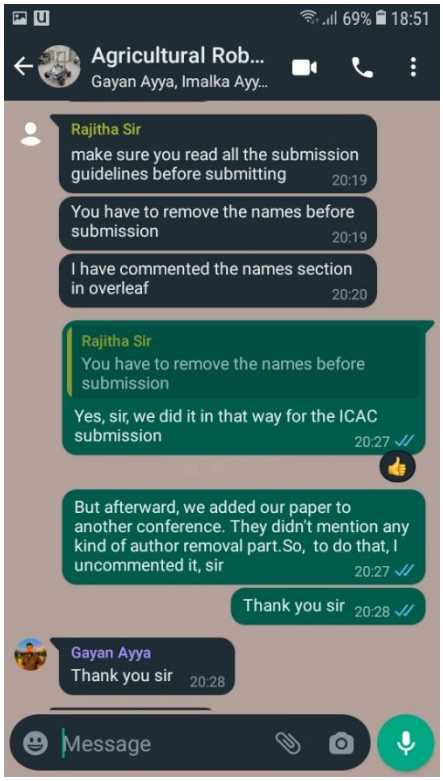
Best Regards,
Rajitha



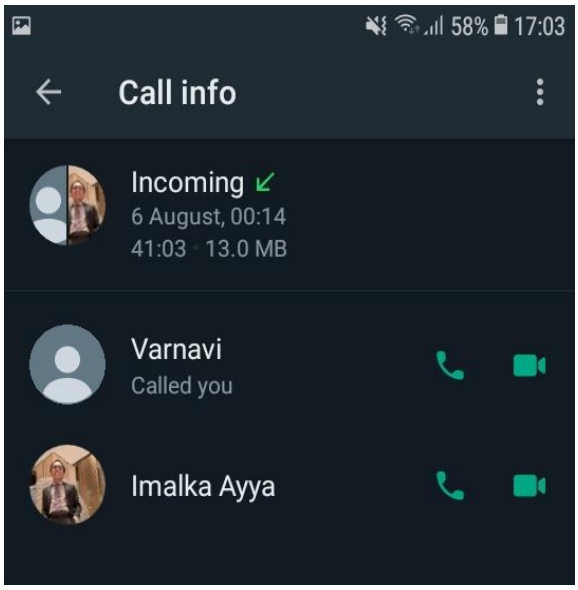


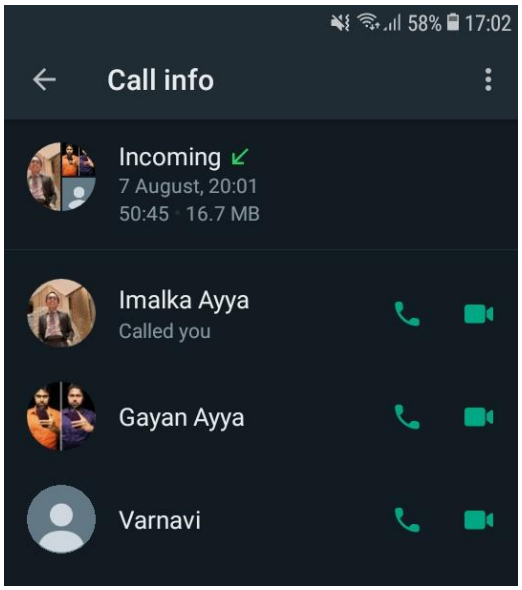
WhatsApp conversations with the external supervisor.

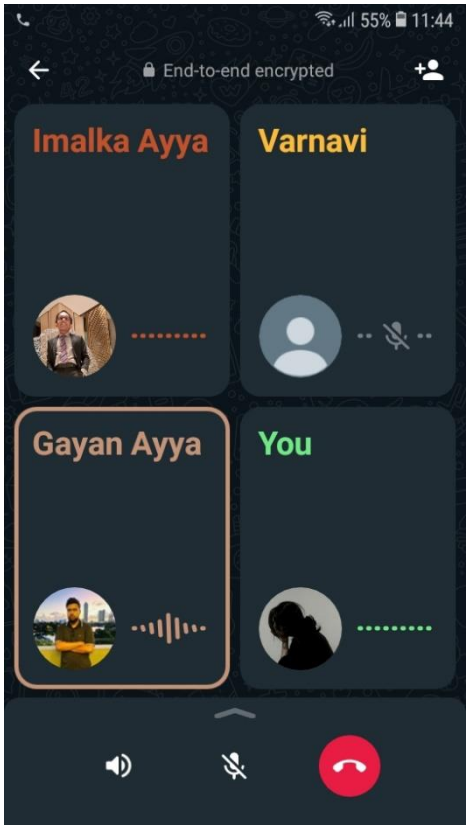


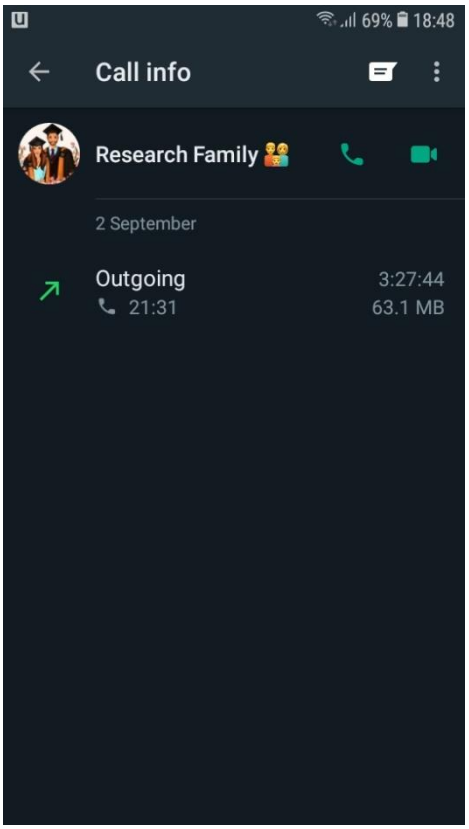


WhatsApp conversations with the team members.









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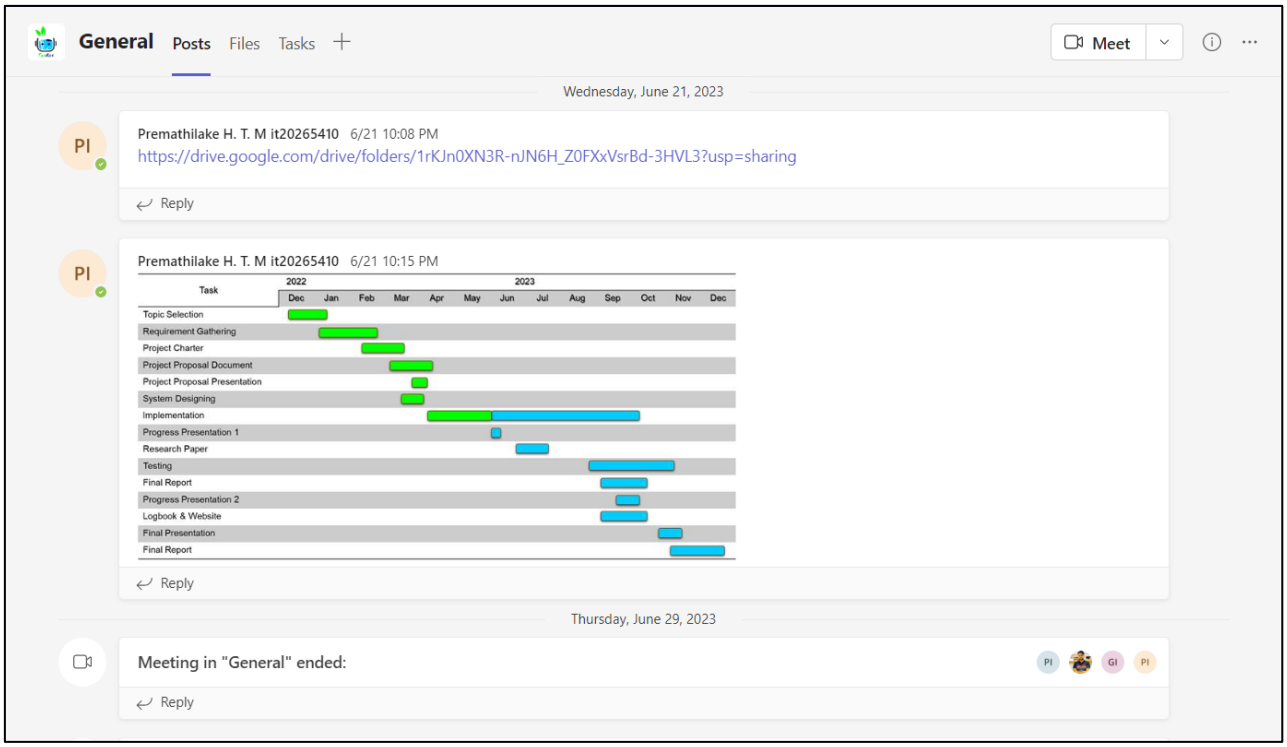
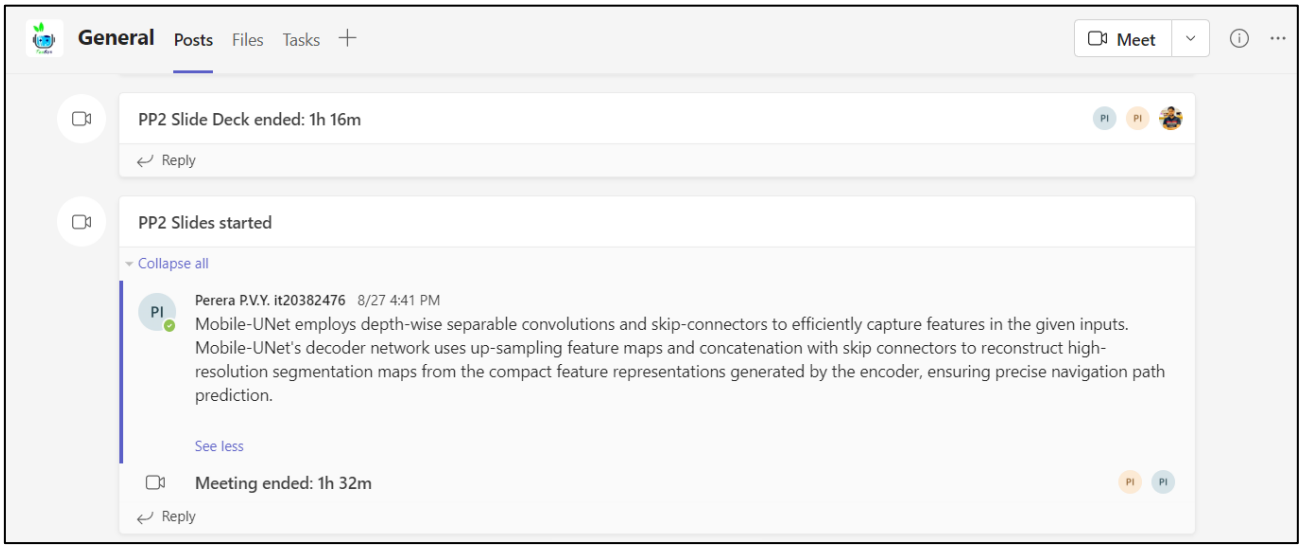
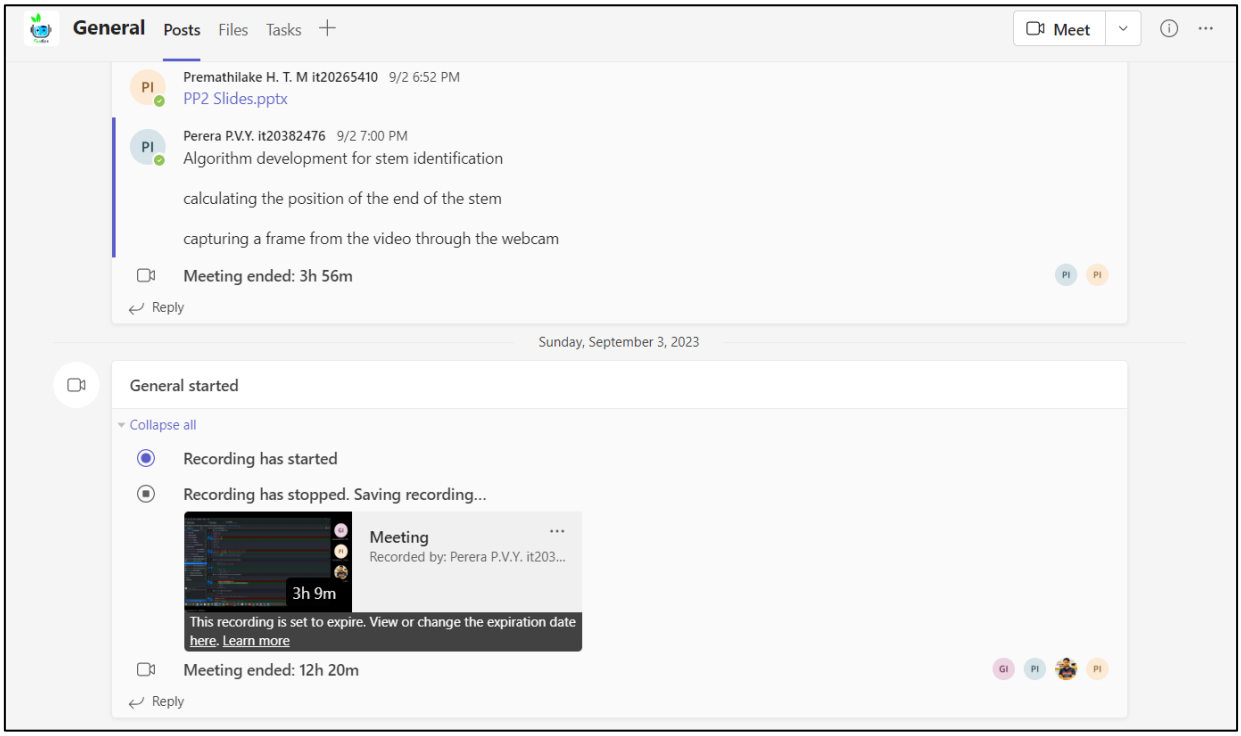
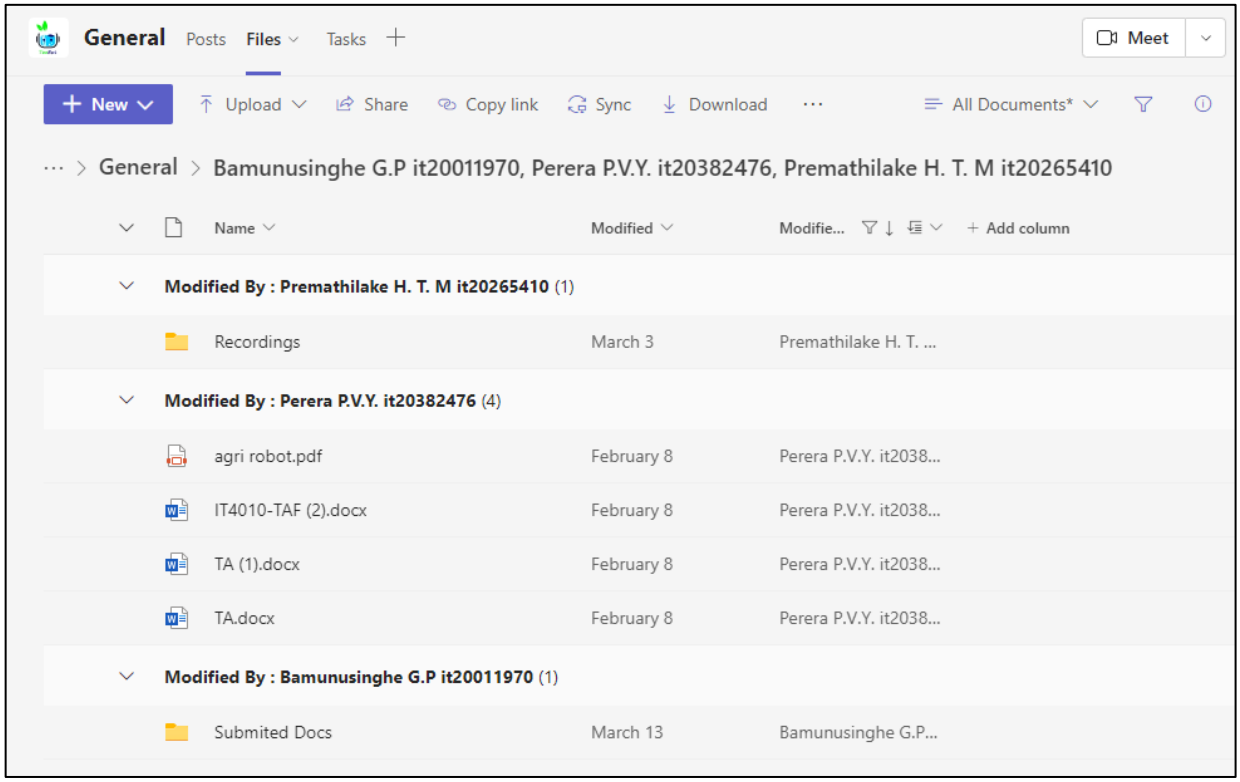





General
Posts
Files
Tasks
Meet
Premathilake H. T. M it20265410 9/2 6:52 PM
PP2 Slides.pptx
Perera P.V.Y. it20382476 9/2 7:00 PM
Algorithm development for stem identification
calculating the position of the end of the stem
capturing a frame from the video through the webcam
Meeting ended: 3h 56m
Reply
Sunday, September 3, 2023
General started
Collapse all
Recording has started
Recording has stopped. Saving recording...
Meeting
Recorded by: Perera P.V.Y. it203...
3h 9m
This recording is set to expire. View or change the expiration date here. Learn more
Meeting ended: 12h 20m
Reply


General
Posts
Files
Tasks
Meet
New
Upload
Share
Copy link
Sync
Download
All Documents*
General > Bamunusinghe G.P it20011970, Perera P.V.Y. it20382476, Prematilake H. T. M it20265410
Name
Modified
Modifie...
Add column
Modified By : Prematilake H. T. M it20265410 (1)
Recordings
March 3
Prematilake H. T. ...
Modified By : Perera P.V.Y. it20382476 (4)
agri robot.pdf
February 8
Perera P.V.Y. it2038...
IT4010-TAF (2).docx
February 8
Perera P.V.Y. it2038...
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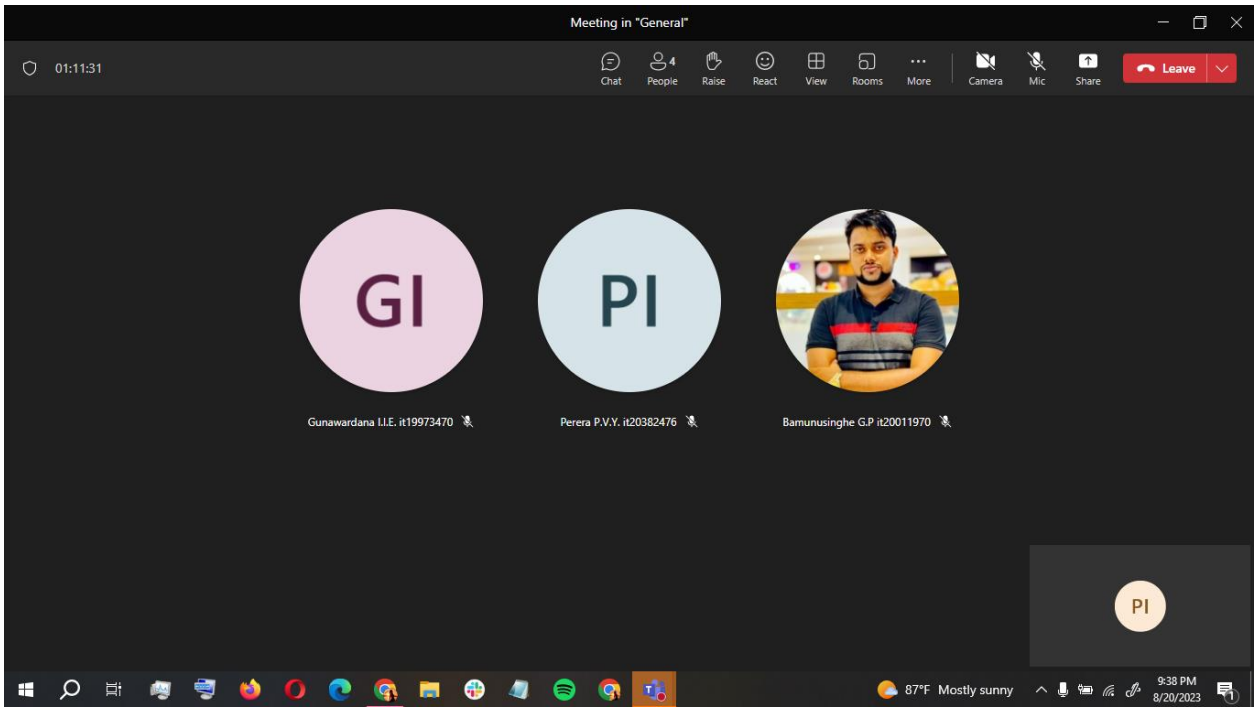
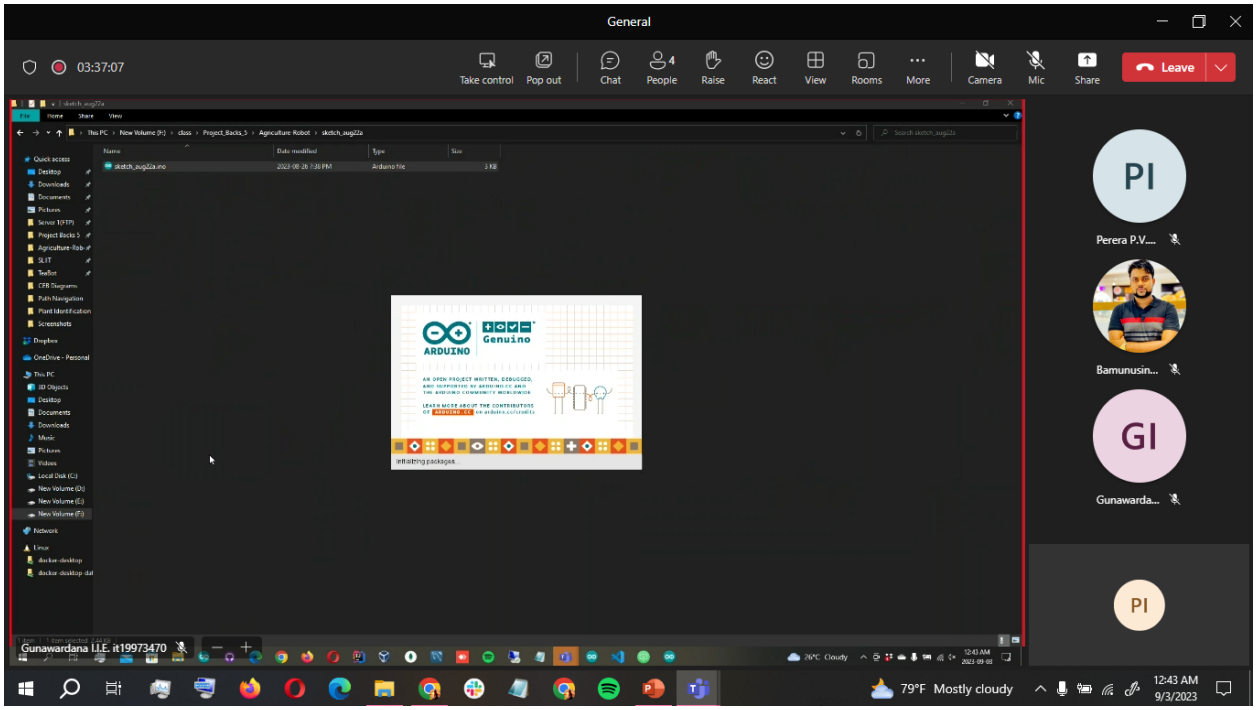
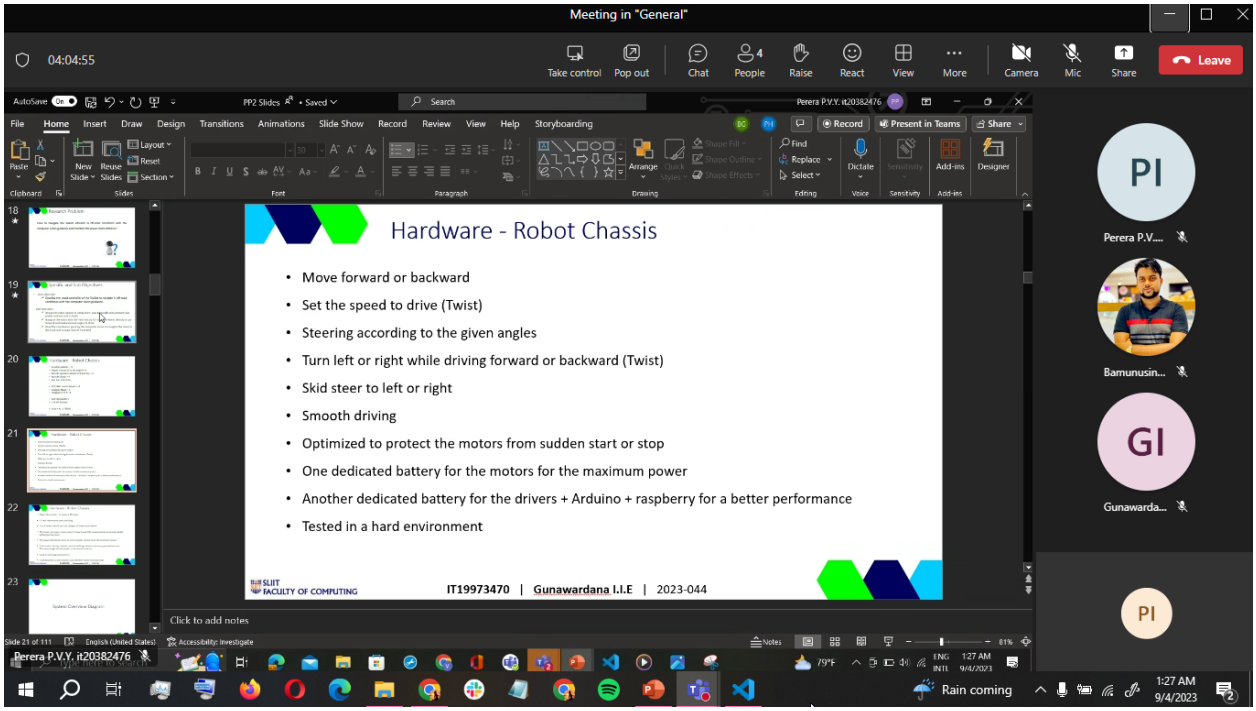
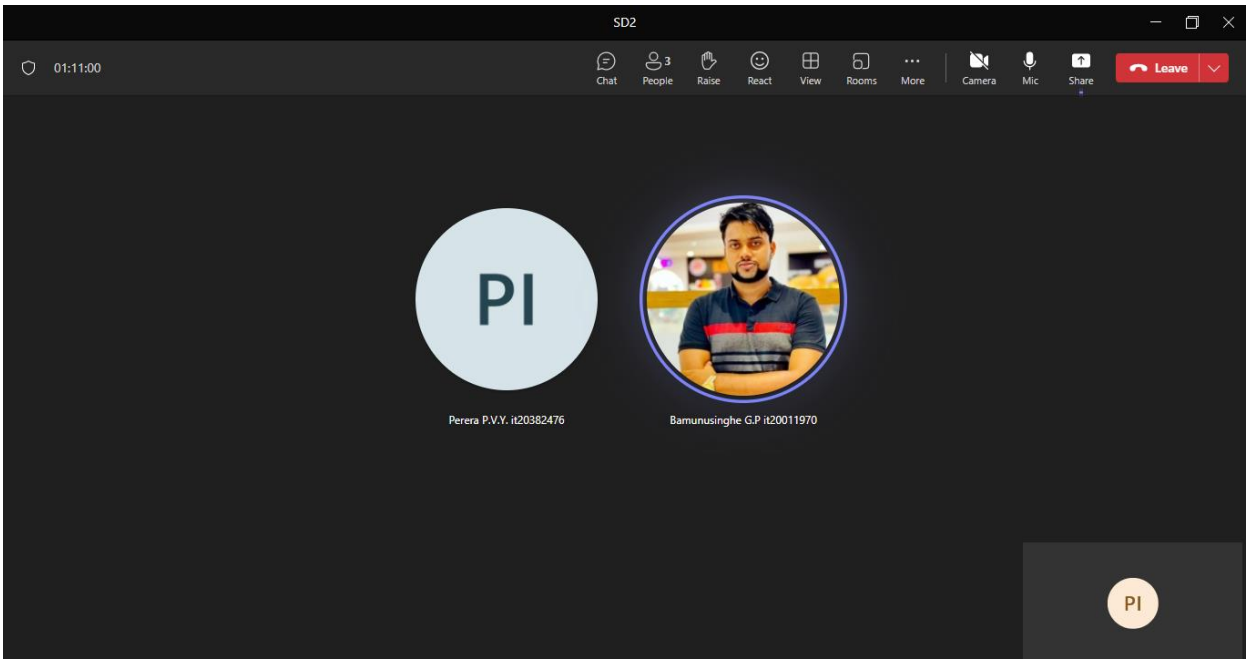
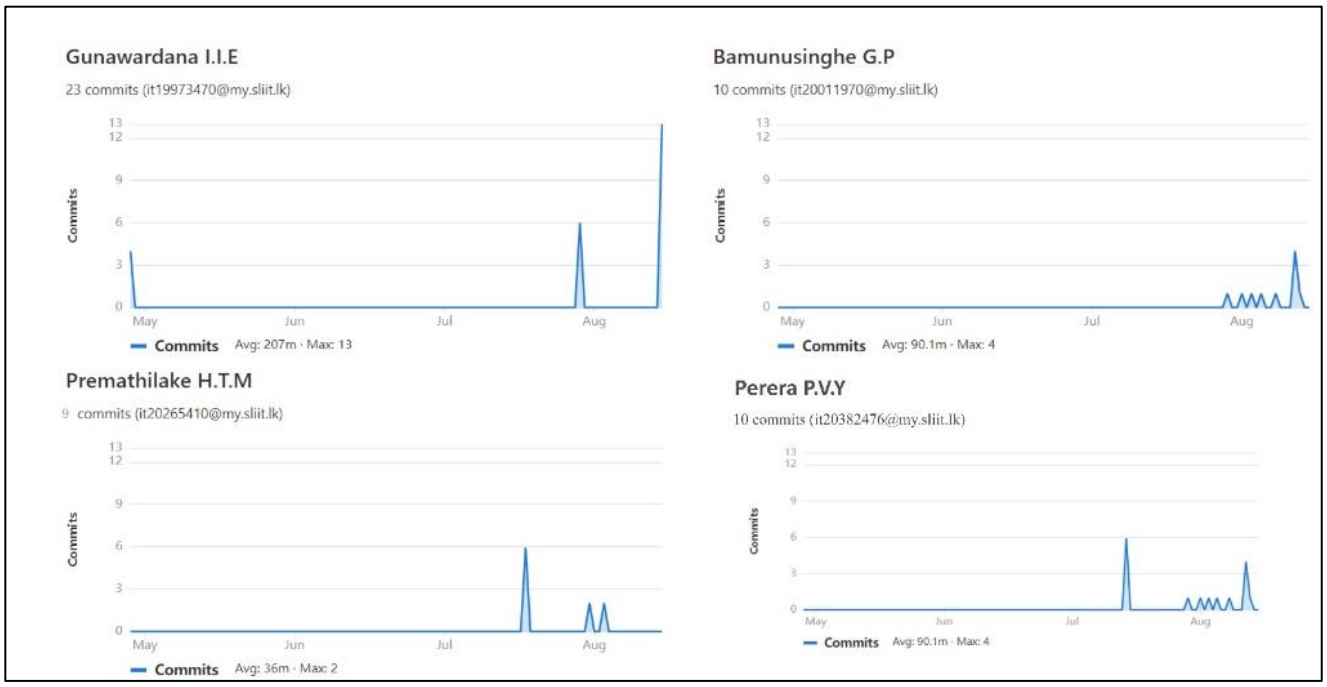

Meeting in "General"
01:11:31
Chat
People
Raise
React
View
Rooms
More
Camera
Mic
Share
Leave
GI
PI
Gunawardana I.I.E. it19973470
Perera P.V.Y. it20382476
Bamunusinghe G.P it20011970
PI
87°F Mostly sunny
9:38 PM
8/20/2023


General
03:37:07
Take control
Pop out
Chat
People
Raise
React
View
Rooms
More
Camera
Mic
Share
Leave
ARDUINO
Genuino
PI
Perera P.V....
Bamunusin...
GI
Gunawarda...
PI
Gunawardana I.I.E. it19973470
79°F Mostly cloudy
12:43 AM
9/3/2023


Meeting in "General"
04:04:55
Take control
Pop out
Chat
People
Raise
React
View
More
Camera
Mic
Share
Leave
Hardware - Robot Chassis
Move forward or backward
Set the speed to drive (Twist)
Steering according to the given angles
Turn left or right while driving forward or backward (Twist)
Skid steer to left or right
Smooth driving
Optimized to protect the motors from sudden start or stop
One dedicated battery for the motors for the maximum power
Another dedicated battery for the drivers + Arduino + raspberry for a better performance
Tested in a hard environment
IT19973470 | Gunawardana I.I.E | 2023-044
Perera P.V.....
Bamunusin...
Gunawarda...
Rain coming
1:27 AM
9/4/2023


SD2
01:11:00
Chat
People
Raise
React
View
Rooms
More
Camera
Mic
Share
Leave
Perera P.V.Y. it20382476
Bamunusinghe G.P it20011970

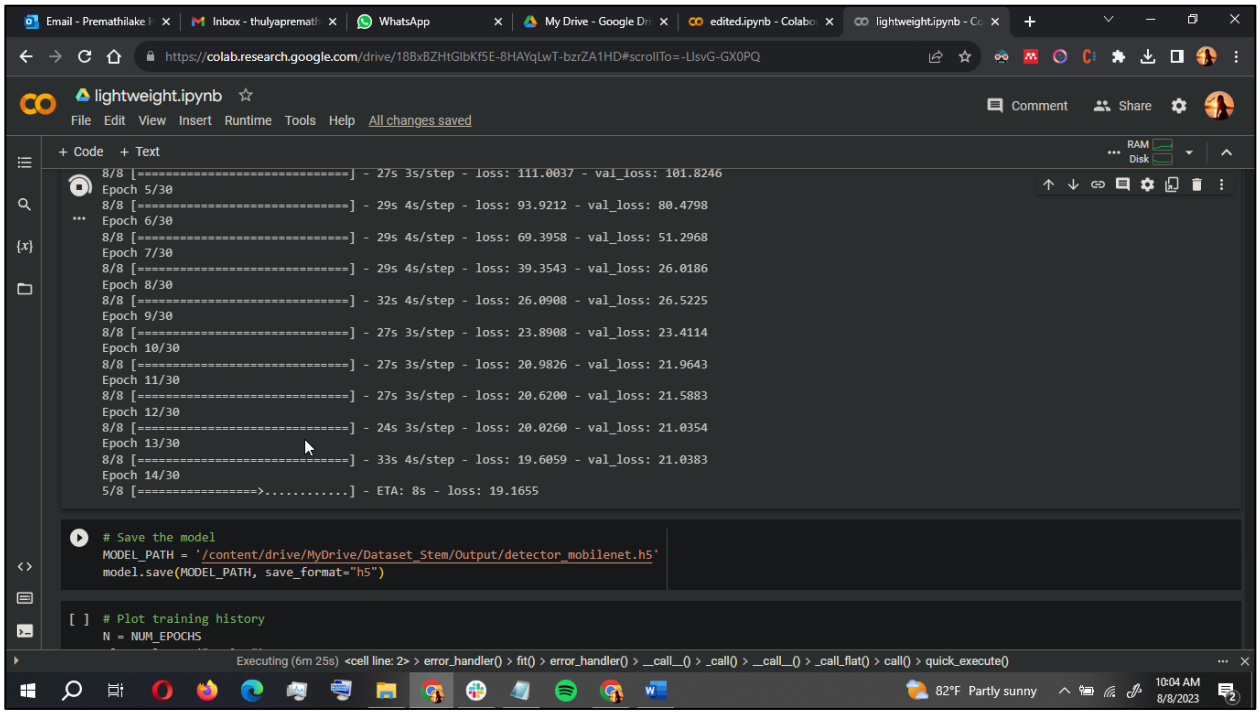
7 GITLAB GRAPHS



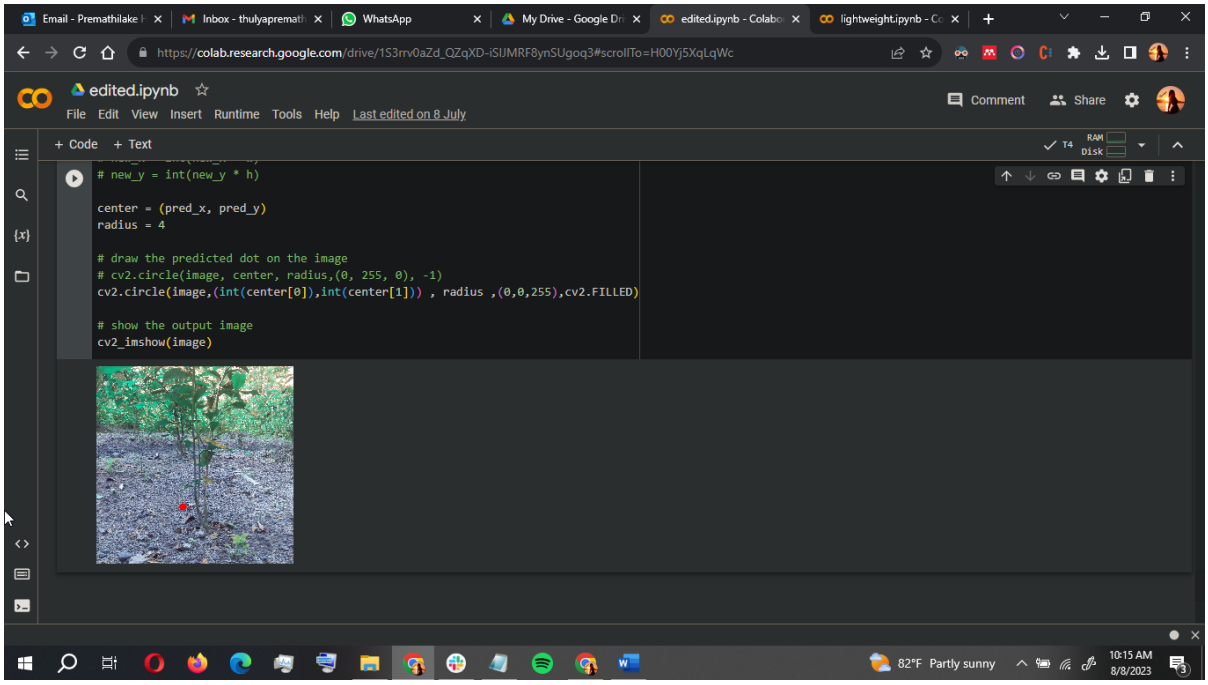
8 DEVELOPED PROTOTYPE

Developed lightweight model based on ResNet50 model to identify the tea stem.

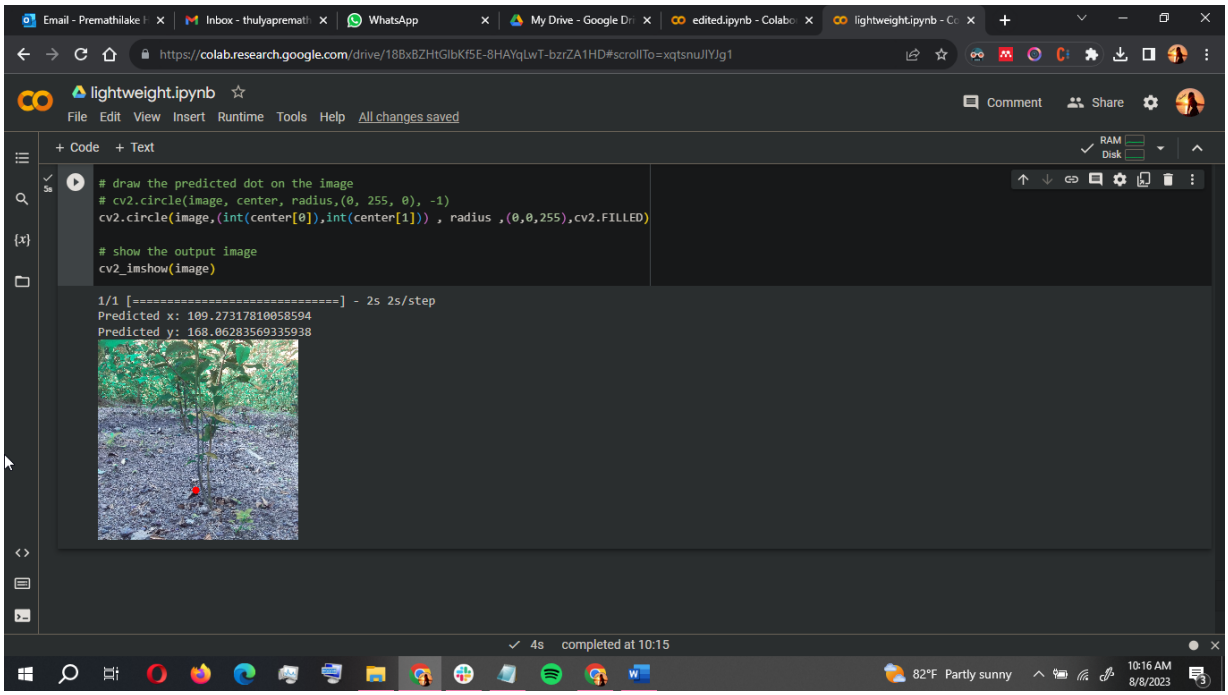
```python
# Load MobileNetV2 model with pre-trained weights (excluding top layers)
base_model = MobileNetV2(weights='imagenet', include_top=False, input_shape=(224, 224, 3))

# Add your custom regression head
x = base_model.output
x = GlobalAveragePooling2D()(x)  # Global average pooling layer
x = Dense(1024, activation='relu')(x)
x = Dense(256, activation='relu')(x)
x = Dense(32, activation='relu')(x)
predictions = Dense(2)(x)  # Output layer with 2 units for x and y coordinates

# Create the model
model = Model(inputs=base_model.input, outputs=predictions)

# Freeze MobileNetV2 layers
for layer in base_model.layers:
    layer.trainable = False

# Compile the model
INIT_LR = 1e-4
NUM_EPOCHS = 30
BATCH_SIZE = 62
loss_fn = Huber()
opt = Adam(INIT_LR)
model.compile(loss=loss_fn, optimizer=opt)
print(model.summary())

# Train the model
H = model.fit(
    trainImages, trainTargets,
    validation_data=(valImages, valTargets),
    batch_size=BATCH_SIZE,
```



Compared the ResNet50 model answer with the developed lightweight model, which is MobileNetV2.

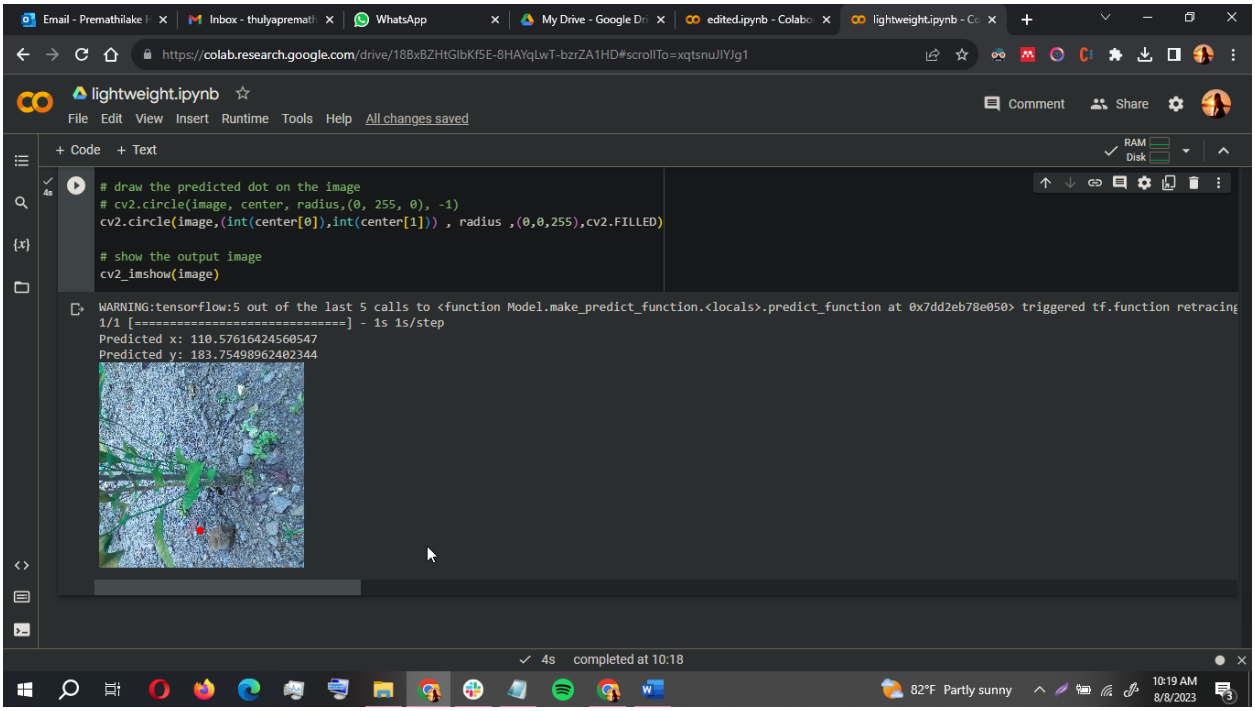


ResNet50 model answer

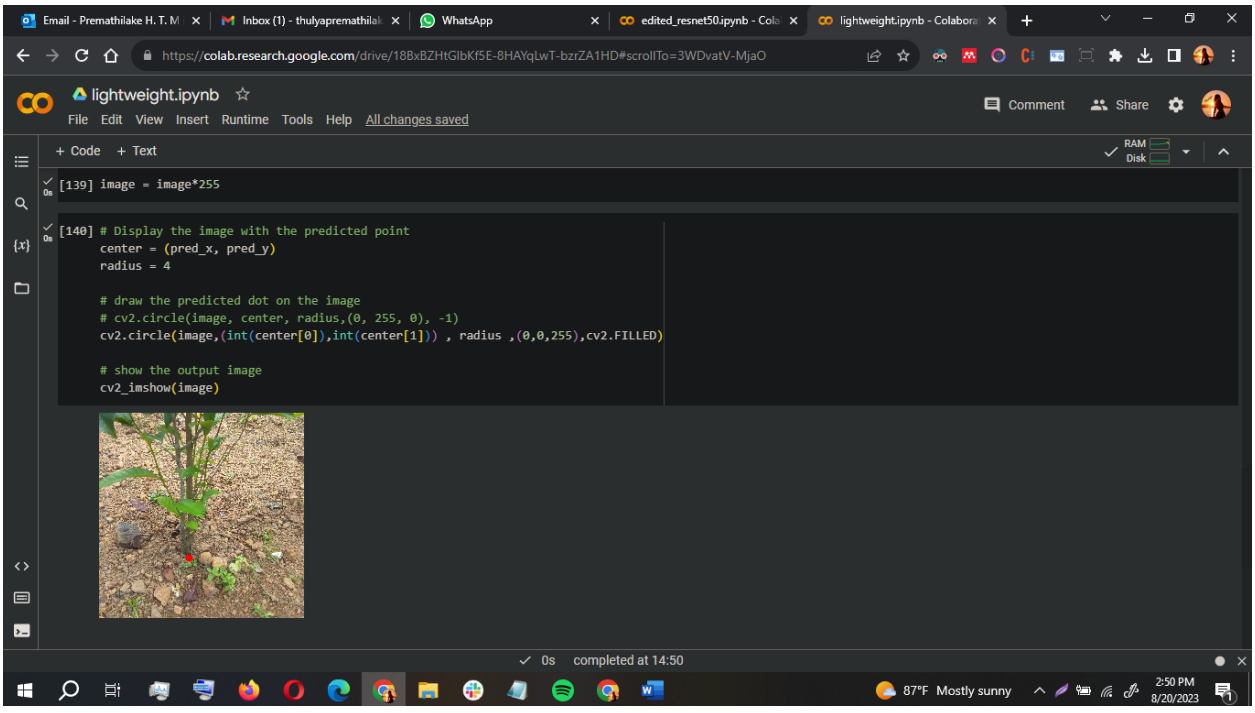


MobileNetV2 model answer

While developing the MobileNetV2 model encountered the error below.



Then it was fixed by using some of the online resources.



But due to the high resource consumption in the model, implemented a classic computer vision-based approach to identify the tea stem.

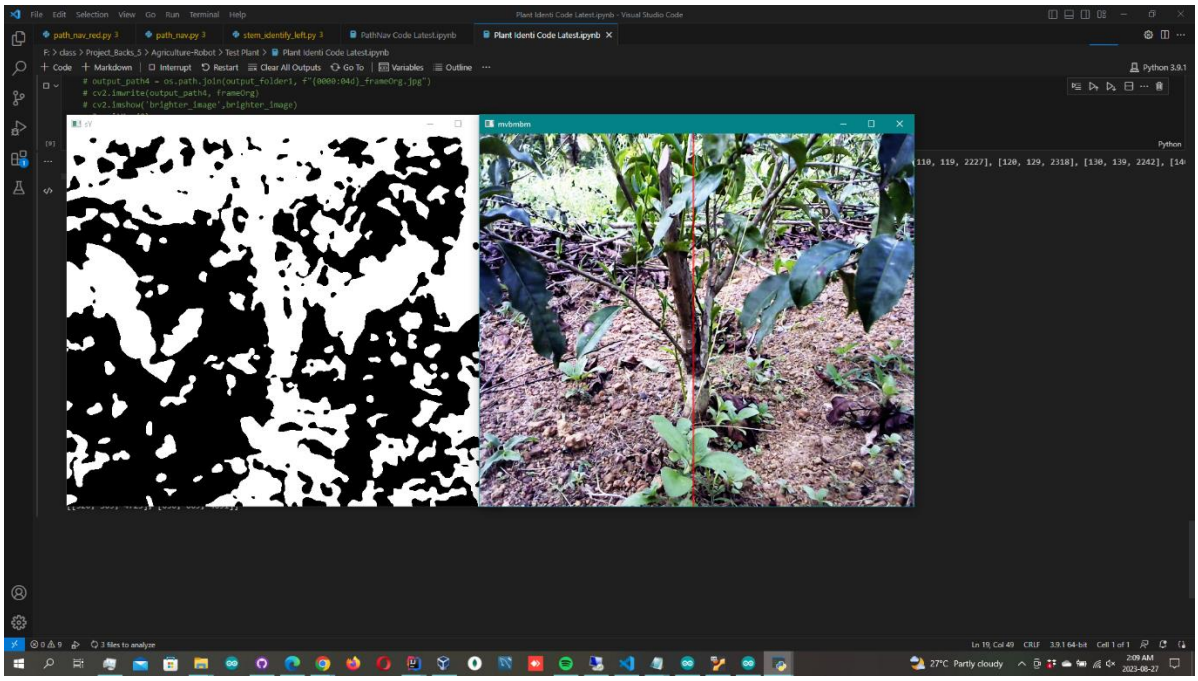
stem_identify_left (1).py | Workspace Trust

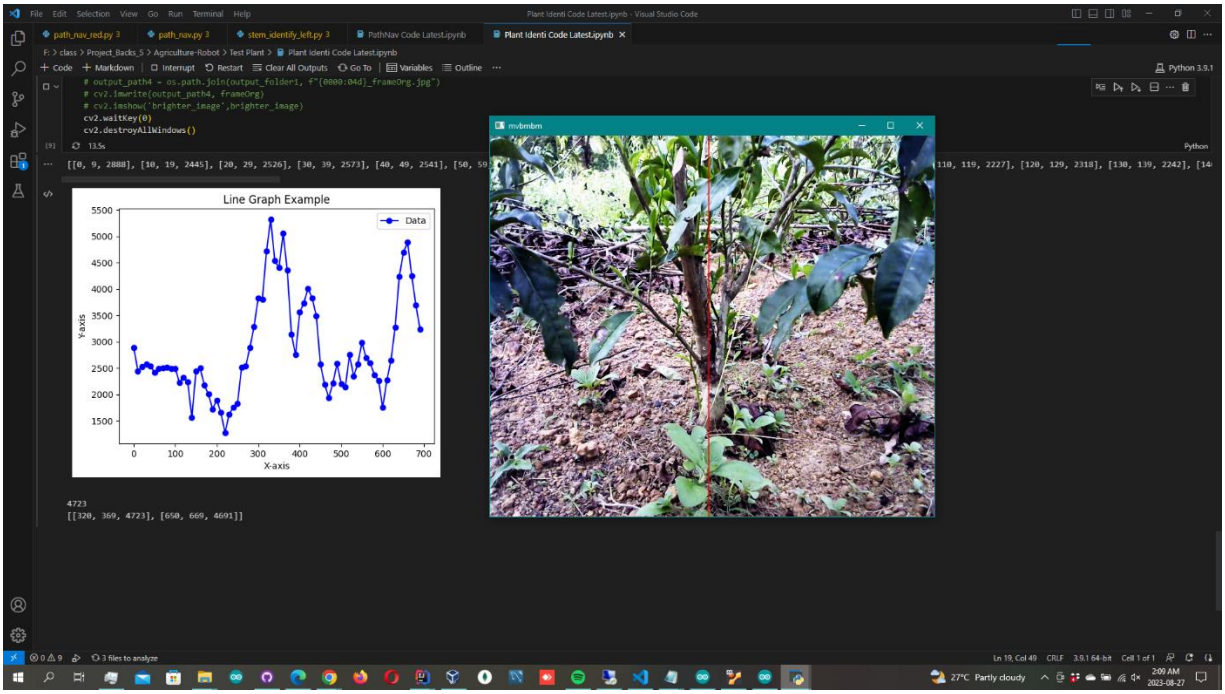
C: > Users > HP > Downloads > stem_identify_left (1).py

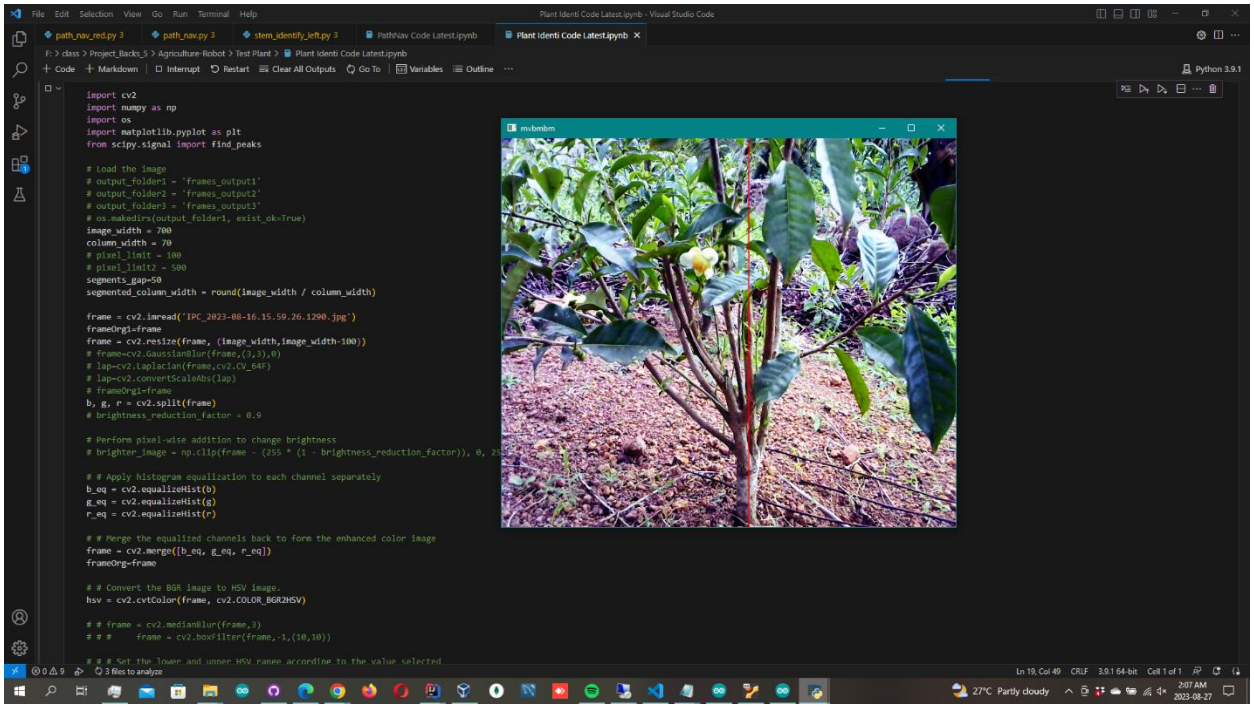
```
        # Split the image into individual color channels (B, G, R)
        frame = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)

        sobel_x = cv2.Sobel(frame, cv2.CV_64F, 1, 0, ksize=3)

        frame = cv2.bitwise_not(frame)

        threshold_value=120
        ret,frame=cv2.threshold(frame,threshold_value,255,cv2.THRESH_BINARY)

        frame[frame < threshold_value] = 0
        frame[frame ≥ threshold_value] = 255

        kernel=np.ones((2,2),np.uint8)
        frame=cv2.erode(frame,kernel,iterations=3)

        blur = cv2.GaussianBlur(frame,(25,25),0)
        frame = cv2.threshold(blur, 100, 255, cv2.THRESH_BINARY)[1]


        areas = stats[1:,cv2.CC_STAT_AREA]

        frame = np.zeros((labels.shape), np.uint8)

        for i in range(0, nlabels - 1):
            frame[labels == i + 1] = 255

        res2=frame
        frameCpy = frameOrg.copy()
        pixel_arr = []
        # loop over the image
```

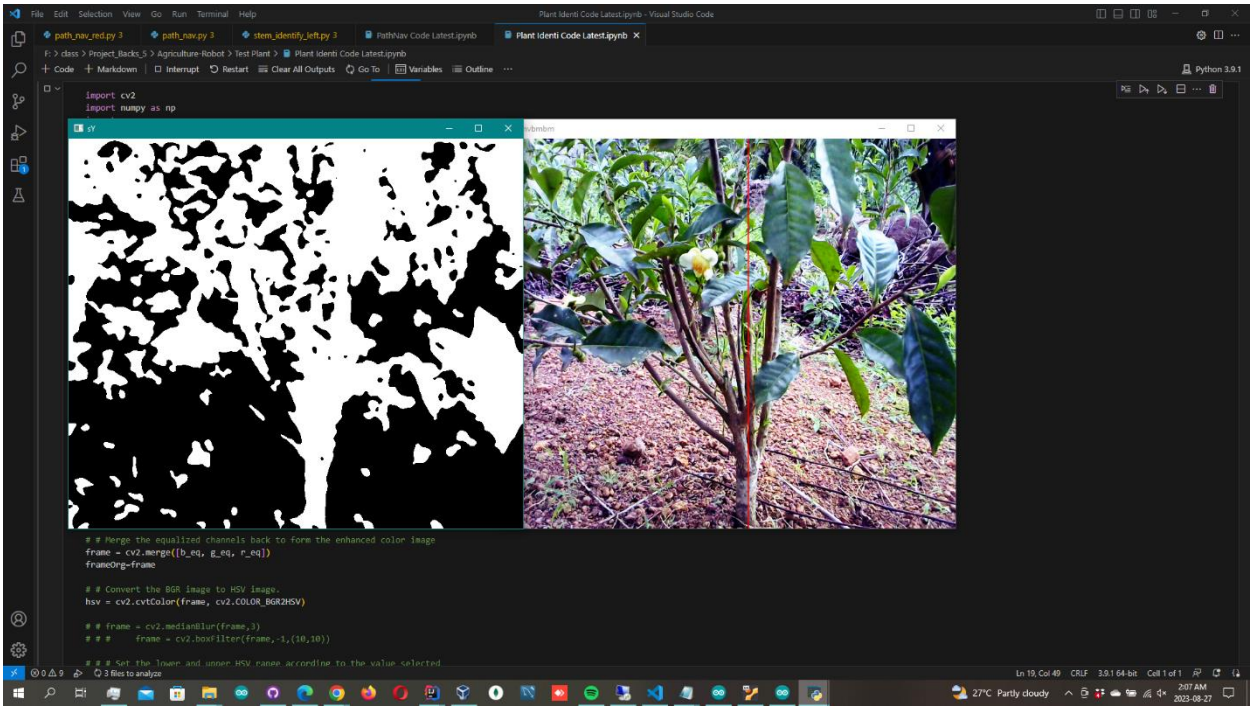
```
        res2=frame
        frameCpy = frameOrg.copy()
        pixel_arr = []
        # loop over the image
        temp_column_number = -1
        for column_number in range(0, image_width):
            if temp_column_number == -1:
                temp_column_number = column_number
            count = count + 1
            column_values = frame[:image_width-100 + 1, column_number]
            column_pixel_count = column_pixel_count + len(column_values[column_values == 255])

        data = np.array(y)
        # Find peaks using scipy's find_peaks function
        # print(pixel_arr)
        temp_pixel_arr = []
        for i in range(0, len(pixel_arr)):
            if pixel_arr[i][2] ≥average_value:
                temp_pixel_arr.append(pixel_arr[i])

        pixel_arr = list(temp_pixel_arr)


        def ascByPixelNumber(k):
            return k[0]


        pixel_arr.sort(key=ascByPixelNumber)
```

Accurate result of the classic computer vision approach.






Plant Identi Code Latest.ipynb - Visual Studio Code
mvbmbm
import cv2
import numpy as np
import os
import matplotlib.pyplot as plt
from scipy.signal import find_peaks
# Load the image
# output_folder1 = 'frames_output1'
# output_folder2 = 'frames_output2'
# output_folder3 = 'frames_output3'
# os.makedirs(output_folder1, exist_ok=True)
image_width = 700
column_width = 70
# pixel_limit = 100
# pixel_limit2 = 500
segments_gap=50
segmented_column_width = round(image_width / column_width)
frame = cv2.imread('IPC_2023-08-16.15.59.26.1298.jpg')
frameOrg1=frame
frame = cv2.resize(frame, (image_width,image_width-100))
# frame=cv2.GaussianBlur(frame,(3,3),0)
# lap=cv2.Laplacian(frame,cv2.CV_64F)
# lap=cv2.convertScaleAbs(lap)
# frameOrg1=frame
b, g, r = cv2.split(frame)
# brightness_reduction_factor = 0.9
# Perform pixel-wise addition to change brightness
# brighter_image = np.clip(frame - (255 * (1 - brightness_reduction_factor)), 0, 25
# # Apply histogram equalization to each channel separately
b_eq = cv2.equalizeHist(b)
g_eq = cv2.equalizeHist(g)
r_eq = cv2.equalizeHist(r)
# # Merge the equalized channels back to form the enhanced color image
frame = cv2.merge([b_eq, g_eq, r_eq])
frameOrg=frame
# # Convert the BGR image to HSV image.
hsv = cv2.cvtColor(frame, cv2.COLOR_BGR2HSV)
# # frame = cv2.medianBlur(frame,3)
# # #   frame = cv2.boxFilter(frame,-1,(10,10))
# # # Set the lower and upper HSV ranges according to the value selected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