LYU1802
BotanWiki

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Supervised by Prof. Lyu Rung Tsong Michael

Overview

AI Model:

Different experiments to enhance recognition

Mobile Application:

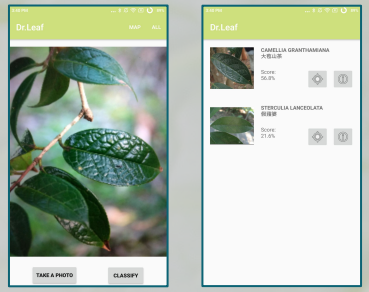
Auto-training Module

Mobile Application

Dr.Leaf

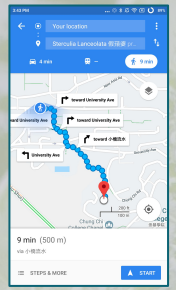
V 1.0

Functionality



Recognition

Look up plants in CUHK



Navigation

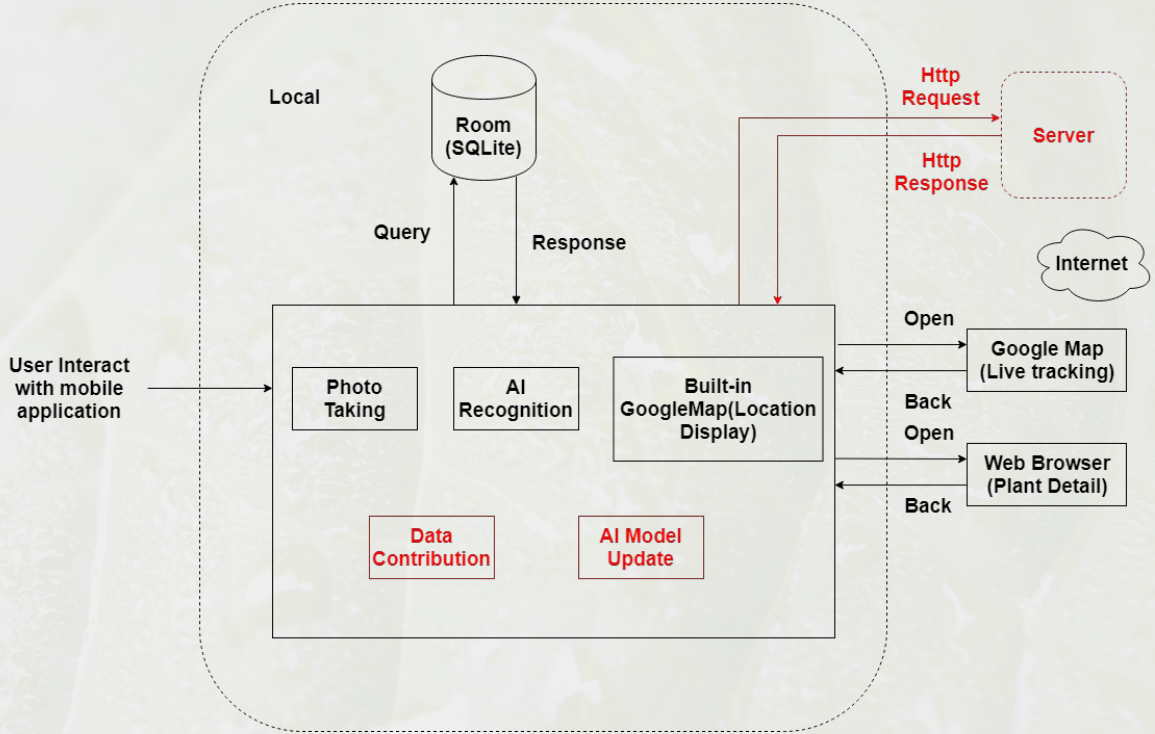
Check out plants detail

Dr.Leaf

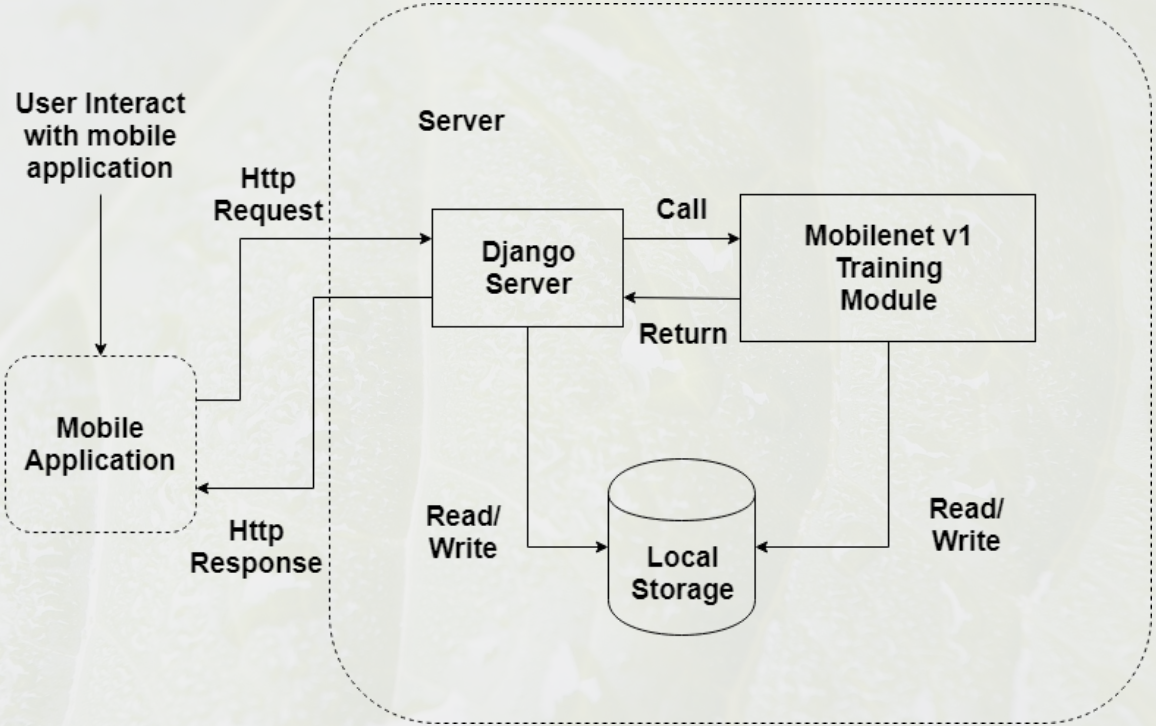
V 2.0

Architecture Design

App-sided Architecture Design



Server-sided Architecture Design




Server
Implementation

Cloud as Server Machine

- Easy to set up
- More flexibility

Django Web Framework

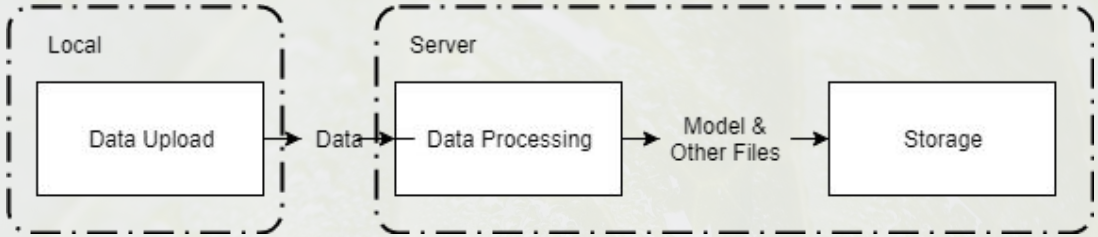
- Rapid server building
- Large python community

Communication Method

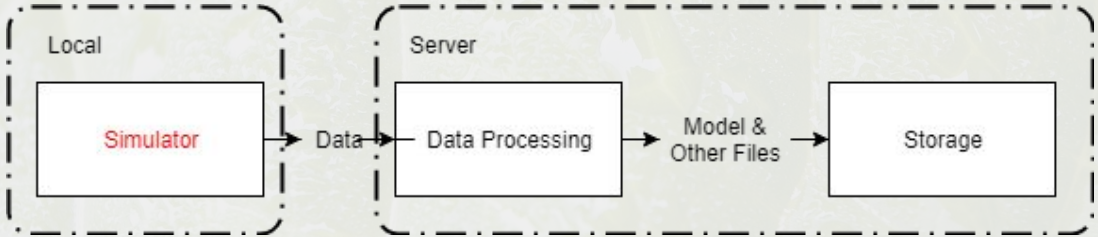
- HTTP
- URI
    - Upload data:
        - http://ip_address:port _number/images
    - Download model:
        - http://ip_address:port _number/models

Testing Technique

Original Design



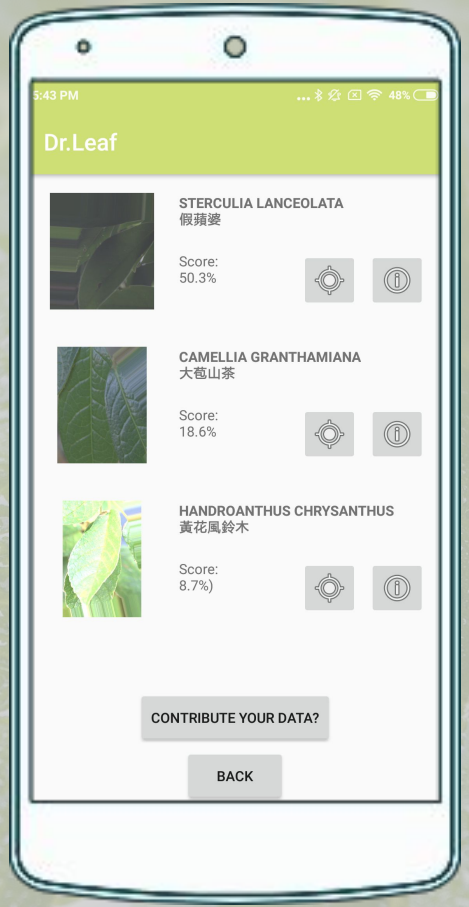
Testing

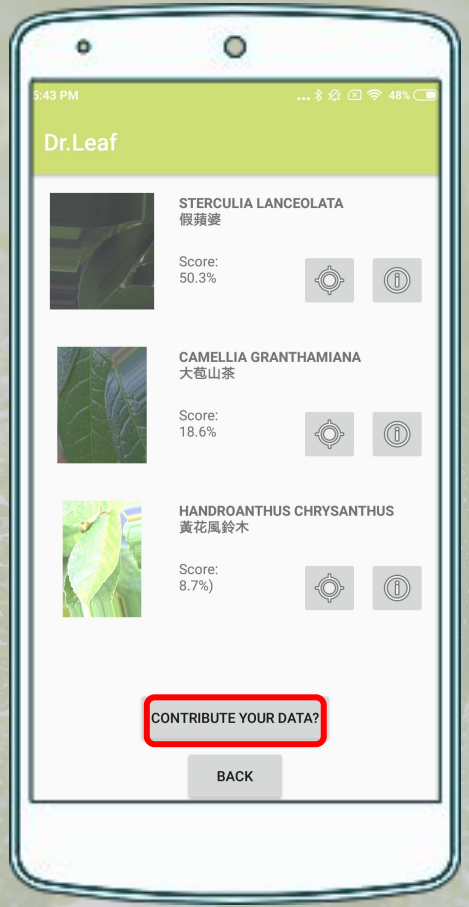


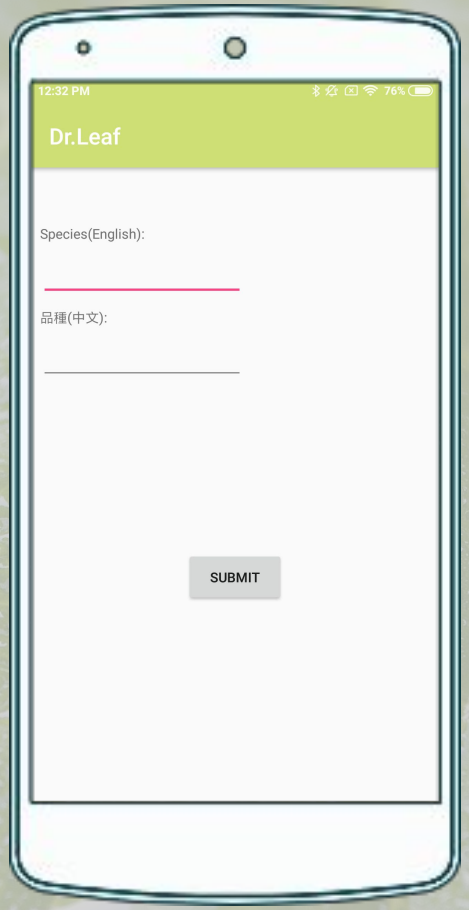
User Interface & Procedure


5:43 PM
48%
Dr.Leaf
DEMO
UPDATE
STEP 1
Take a photo of the leaf
STEP 2
Classify it!
85%
TAKE A PHOTO
CLASSIFY


Dr.Leaf
DEMO
UPDATE
TAKE A PHOTO
CLASSIFY

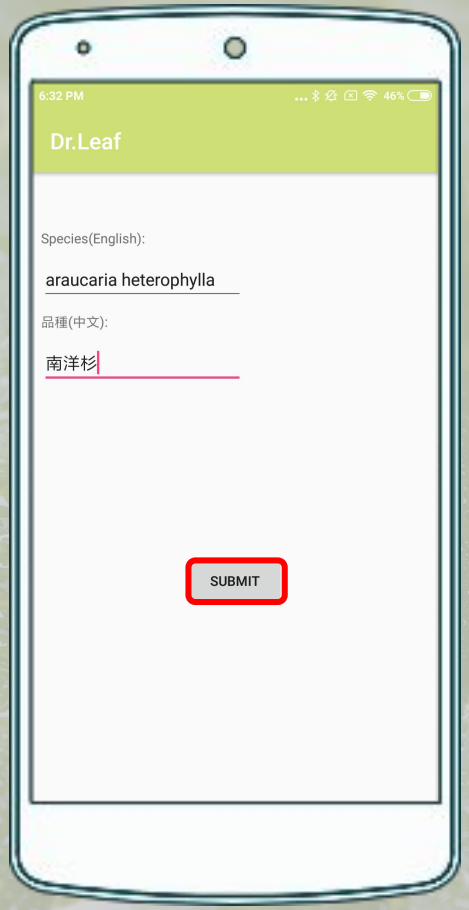

5:43 PM
48%
Dr.Leaf
STERCULIA LANCEOLATA
假蘋婆
Score:
50.3%
CAMELLIA GRANTHAMIANA
大苞山茶
Score:
18.6%
HANDROANTHUS CHRYSANTHUS
黃花風鈴木
Score:
8.7%)
CONTRIBUTE YOUR DATA?
BACK


5:43 PM
48%
Dr.Leaf
STERCULIA LANCEOLATA
假蘋婆
Score:
50.3%
CAMELLIA GRANTHAMIANA
大苞山茶
Score:
18.6%
HANDROANTHUS CHRYSANTHUS
黃花風鈴木
Score:
8.7%)
CONTRIBUTE YOUR DATA?
BACK


12:32 PM
76%
Dr.Leaf
Species(English):
品種(中文):
SUBMIT

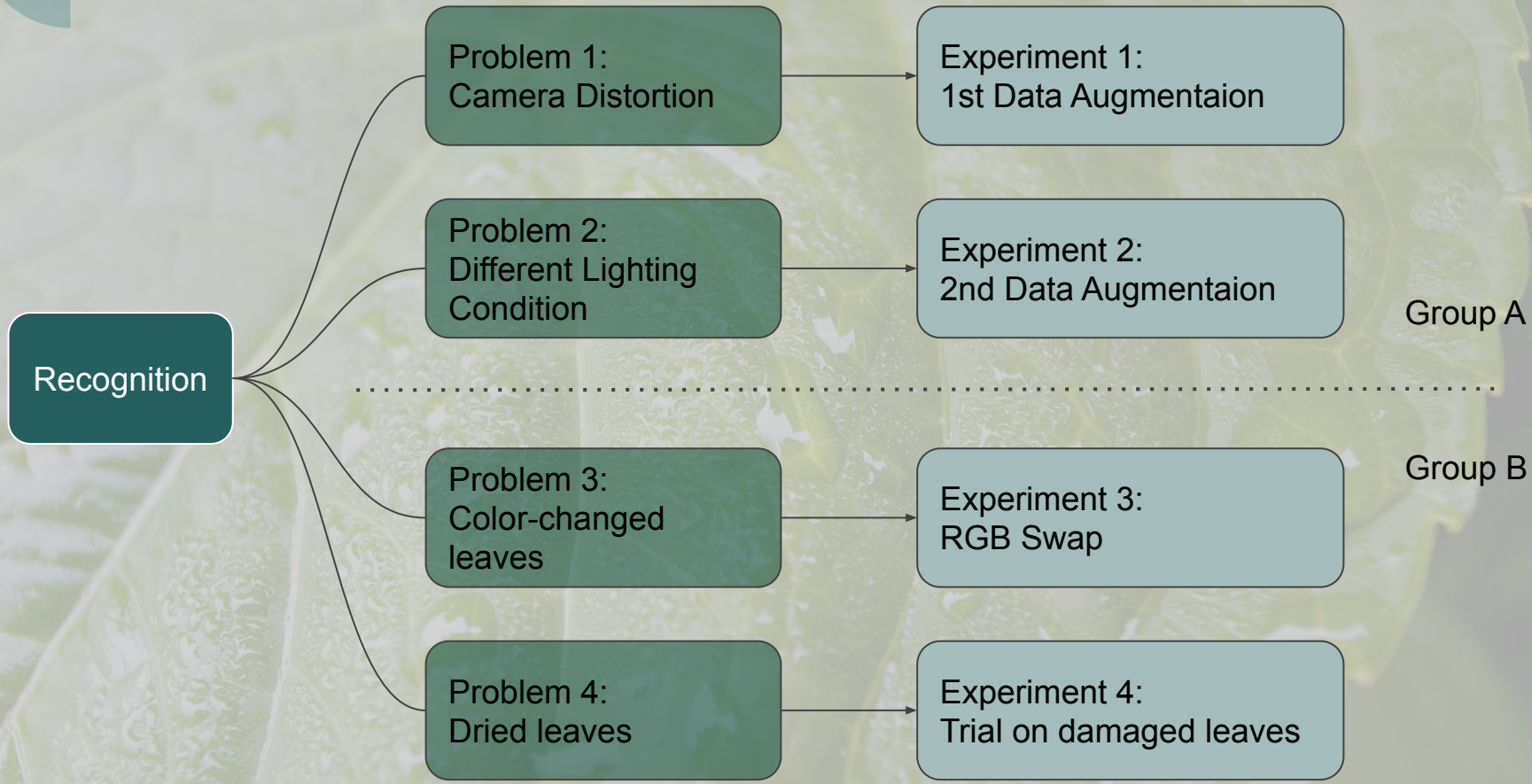
One Interface, Two Purpose

- Correct labelling into existing ones
- Add new species


6:32 PM
46%
Dr.Leaf
Species(English):
araucaria heterophylla
品種(中文):
南洋杉
SUBMIT

AI Model

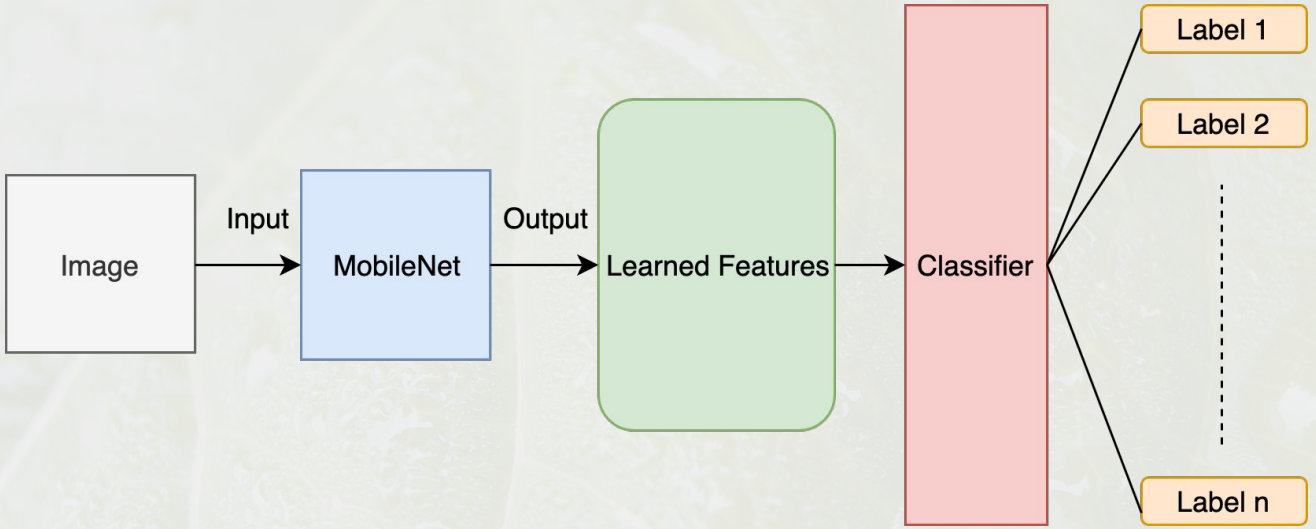
Overview - 1


Recognition
Problem 1:
Camera Distortion
Problem 2:
Different Lighting
Condition
Problem 3:
Color-changed
leaves
Problem 4:
Dried leaves
Experiment 1:
1st Data Augmentaion
Experiment 2:
2nd Data Augmentaion
Experiment 3:
RGB Swap
Experiment 4:
Trial on damaged leaves
Group A
Group B

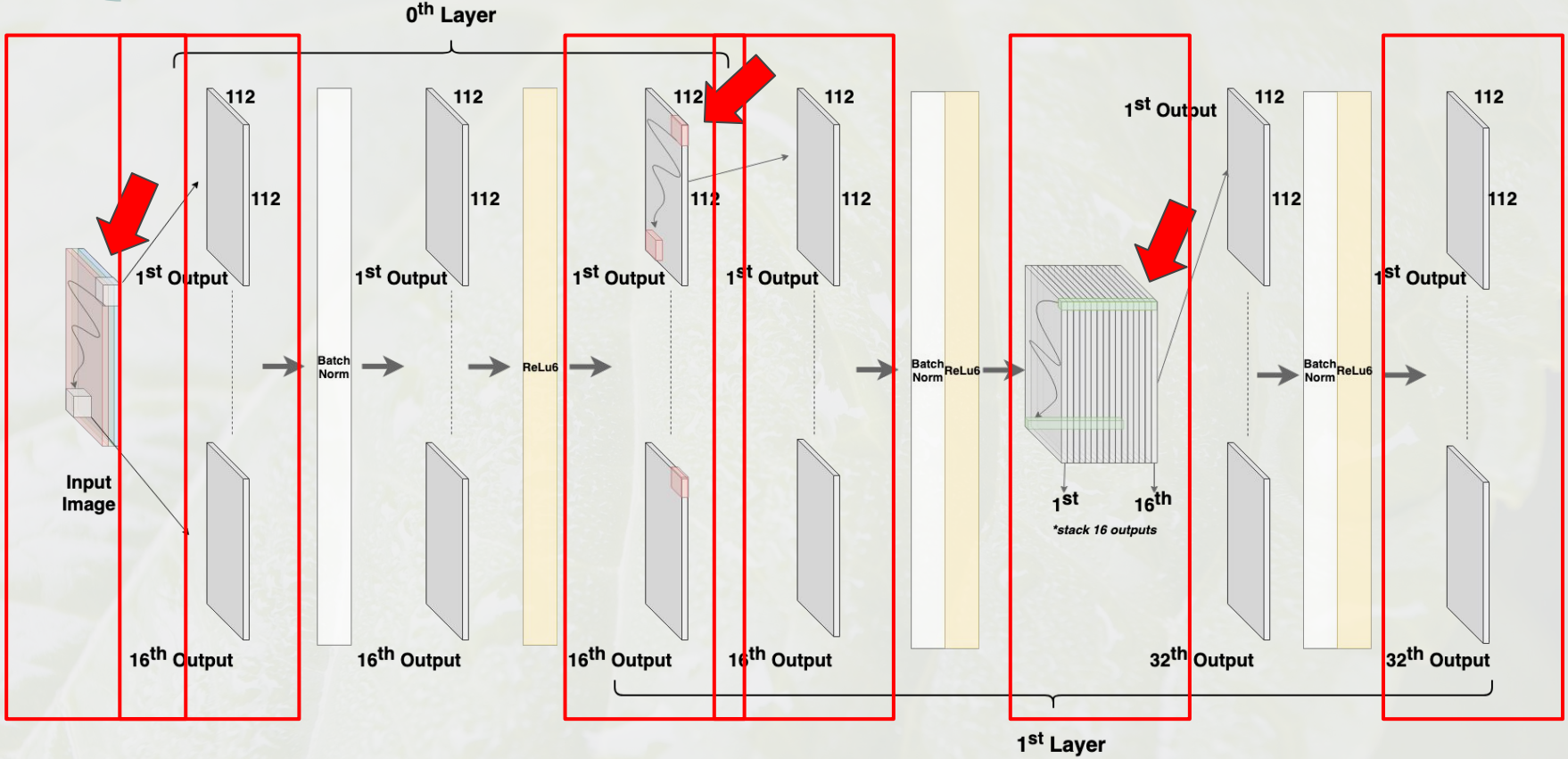
Overview - 2


Visualization
Experiment 2:
2nd Data Augmentaion
Experiment 3:
RGB Swap
Experiment 4:
Trial on damged leaves
Problem 2:
Different Lighting
Condition
Problem 3:
Color-changed
leaves?
Problem 4:
Dried leaves

why visualzation?



where to visualize?



Example of visualization

Table 17: Features in the first layer of leaf label CA

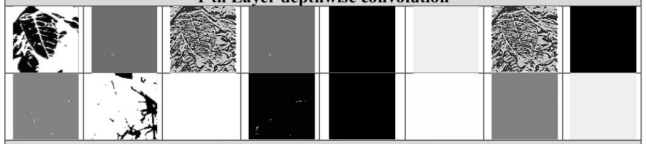
Input Image

Index of output in a layer:

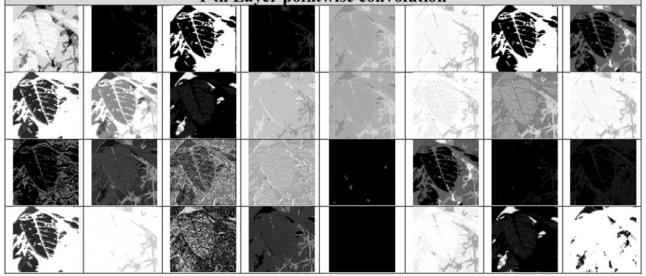
0-th Layer							
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
9	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1-th Layer depthwise convolution							
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
9	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1-th Layer pointwise convolution							
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
9	*10*	*11*	*12*	*13*	*14*	*15*	*16*
17	*18*	*19*	*20*	*21*	*22*	*23*	*24*
25	*26*	*27*	*28*	*29*	*30*	*31*	*32*

0-th Layer

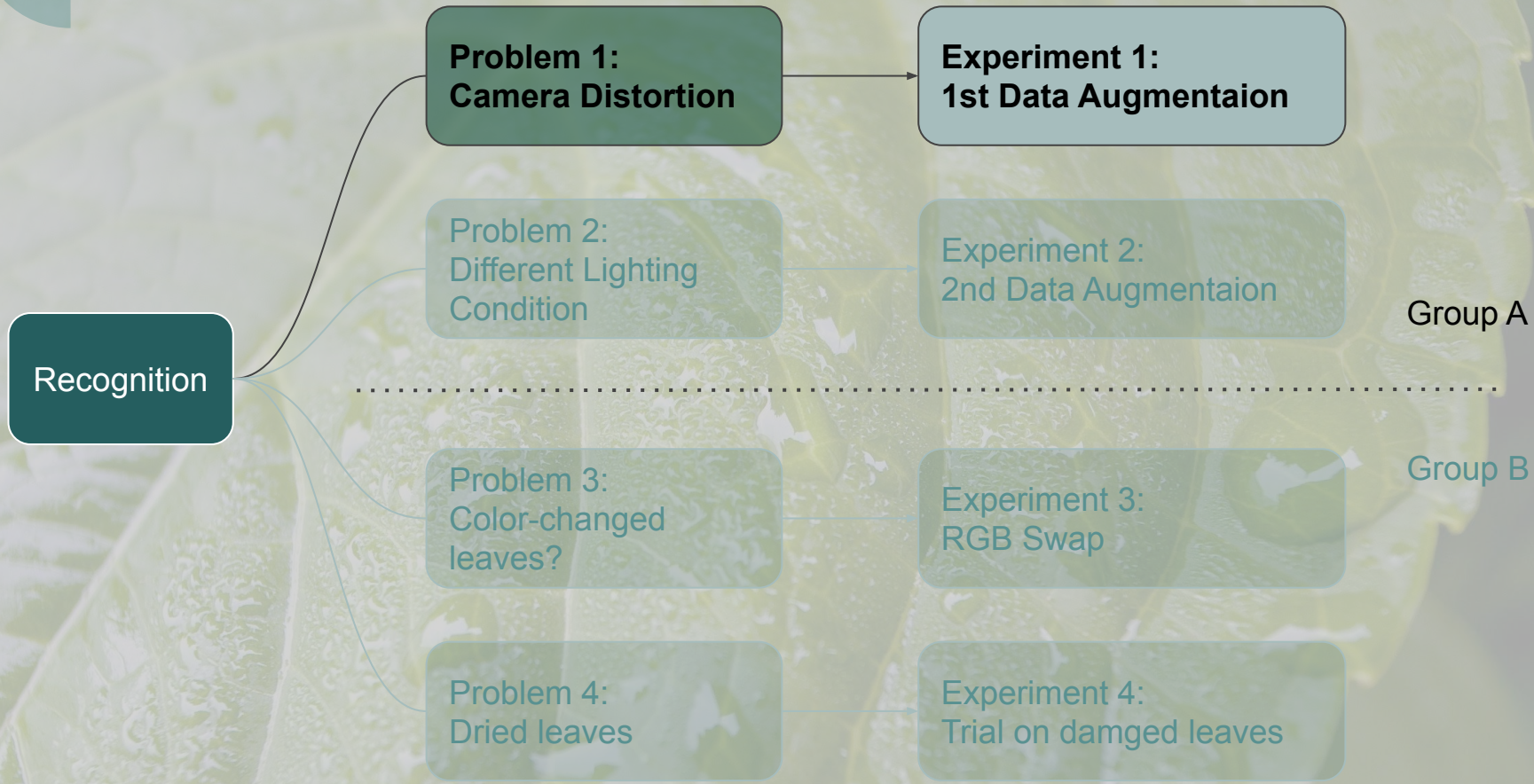
1-th Layer depthwise convolution



1-th Layer pointwise convolution



Problem 1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Experiment 2:
2nd Data Augmentaion
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Recognition
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leaves?
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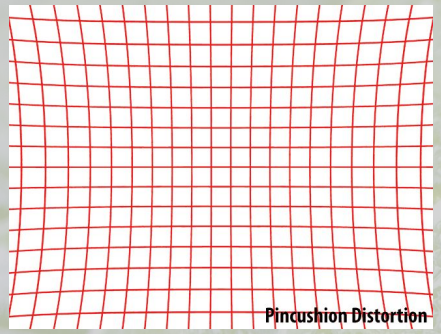
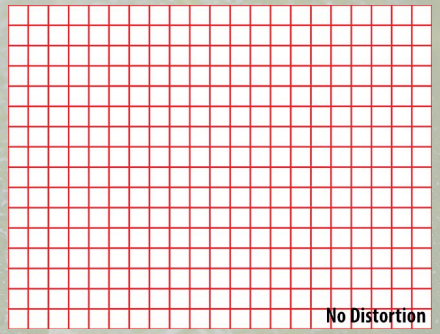
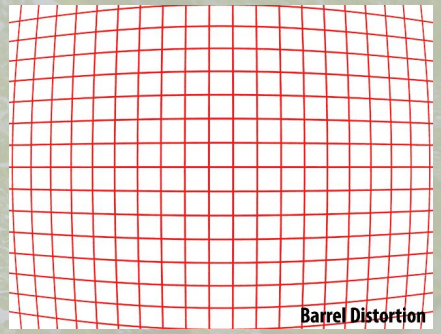
RGB Swap
Group B
Problem 4:
Dried leaves
Experiment 4:
Trial on damged leaves

Distortion

User may take picture from different angles.







[1] Images are taken from the online resouce, https://photographylife.com/what-is-distortion

Augmentation

1. Rotation within 40 degrees
2. Width and Height shifting 20%
3. Shearing
4. Zoom in or out within 20%
5. Flip horizontally
6. Fill Point outside the boundaries with the nearest data

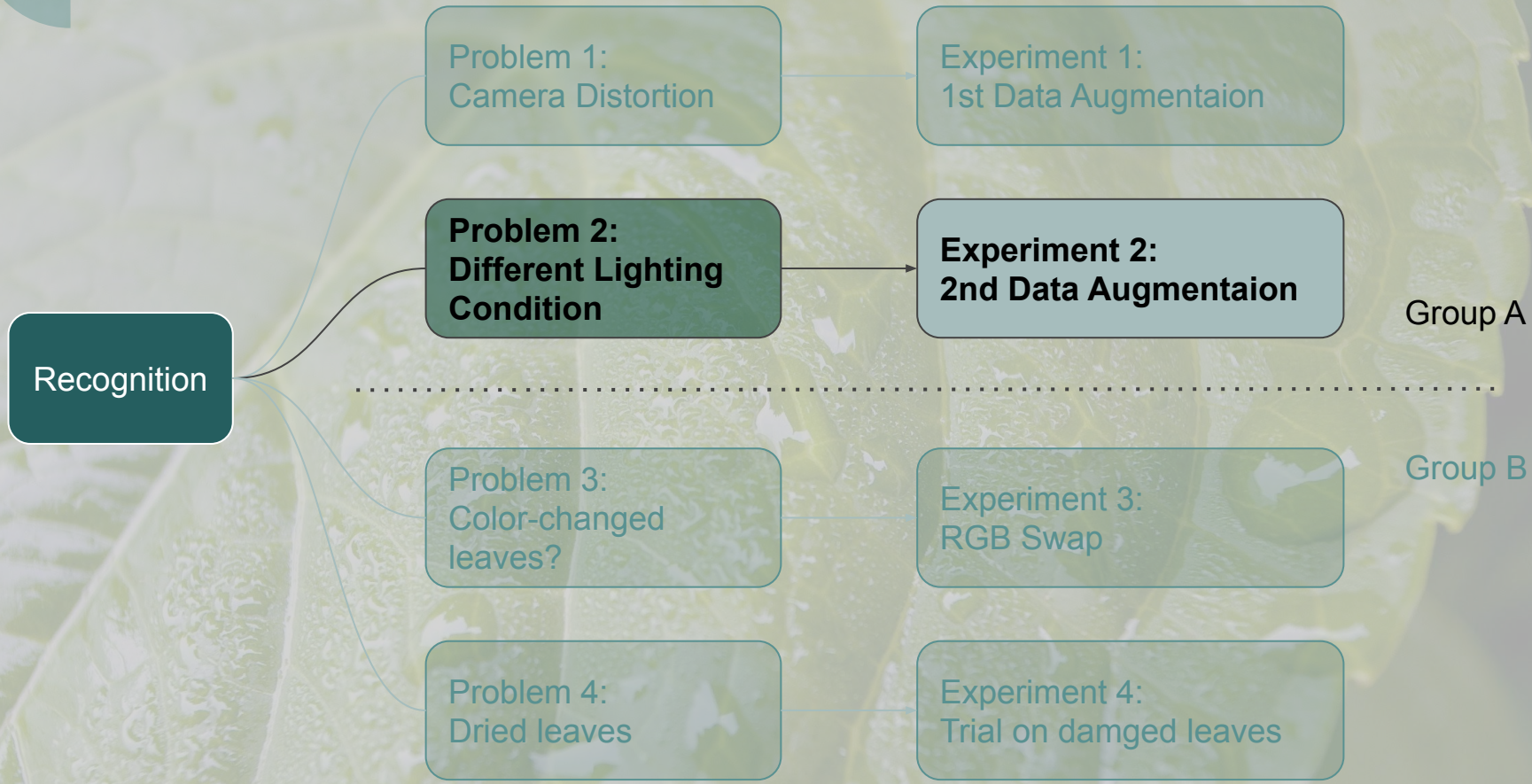
Procedure

1. Install the application in mobile phone
2. Take photo of real leaves for 10 times
3. Record the prediction score

Result

Label	Origin	1st	Net Result
BV	37.65	59.63	21.98
CB	57.99	31.39	-26.6
CG	75.97	78.7	2.73
FA	7.78	35.91	28.13
HC	4.84	22.21	17.37
HR	61.43	75.04	13.61
SL	17.75	28.14	10.39
Average	37.63	47.28857143	9.658571429

Problem 2


Recognition
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Trial on damged leaves

Motivation

Simulate the scenario of taking picture under different lighting environments

→ Data augmentation regarding lighting

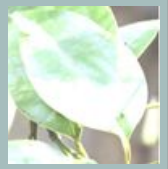
Specification

$$[R',G',B']=c*cnum* [R,G,B]+[\beta,\beta,\beta]$$

i) [**R′**, **G′**, **B′]** is the output image
ii) c=0.1
iii) cnum is the contrast variable
iv) **β** is the brightness variable,which has the same dimension of a color channel in the input image
v) [**R**, **G**, **B]** is the input image

Specification

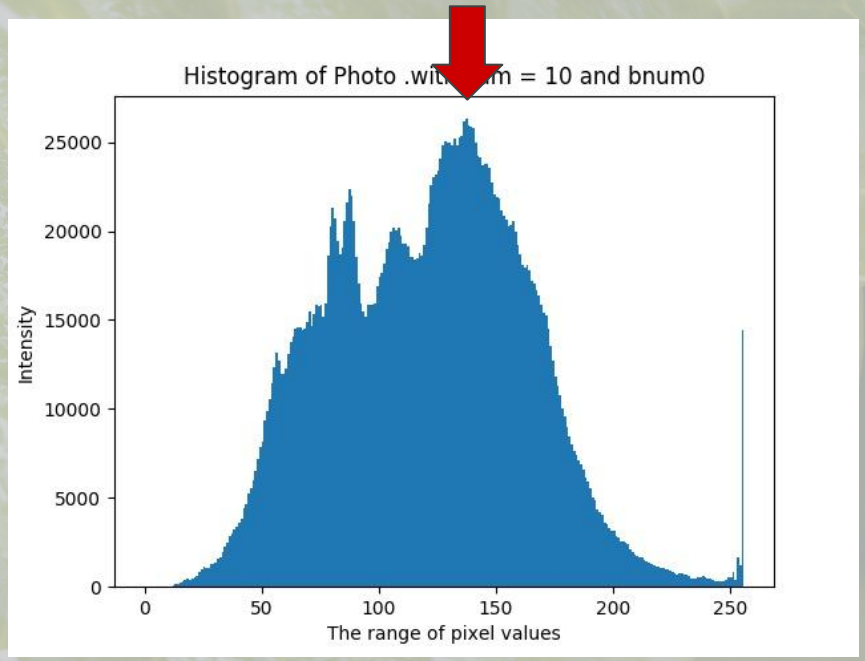
SET 1: Extreme lighting condition

Iteration	1	2	3	4
Variables	c=0.1 β=0 cnum=5	c=0.1 β=50 cnum=5	c=0.1 β=0 cnum=15	c=0.1 β=50 cnum=15
Image				

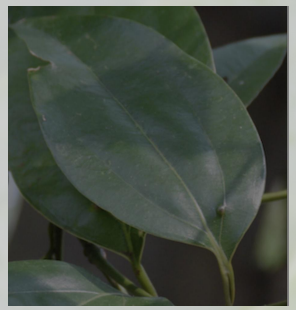
SET 2: Acceptable range of exposure measured with histogram

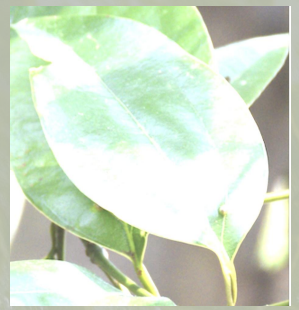
Iteration	1	2	3	4
Variables	c=0.1 β=50 cnum=5	c=0.1 β=10 cnum=10	c=0.1 β=30 cnum=10	c=0.1 β=50 cnum=10
image				

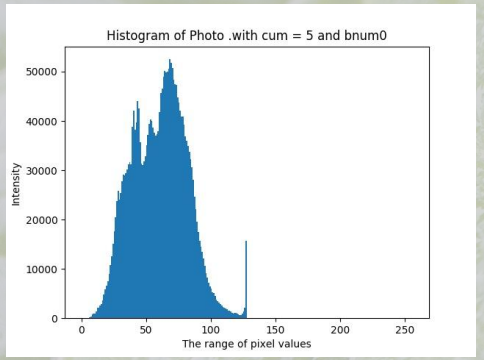
Historgram

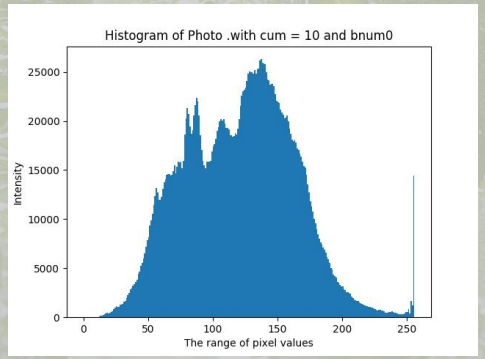

Histogram of Photo .wit m = 10 and bnum0
25000
20000
15000
10000
5000
0
Intensity
0
50
100
150
200
250
The range of pixel values

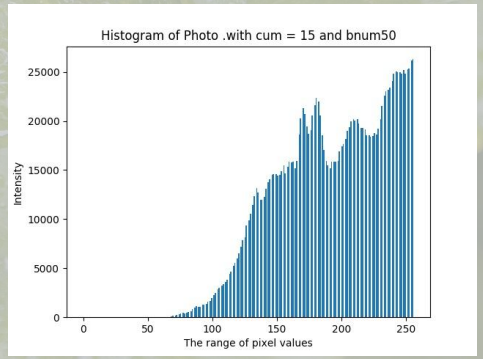
Historgram









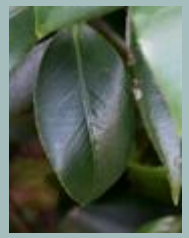


Underexposed

Correctly exposed

Overexposed

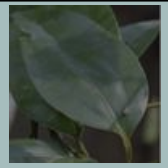
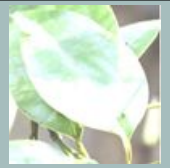
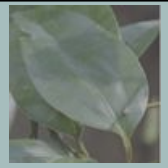
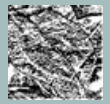
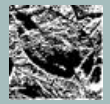
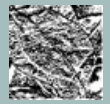
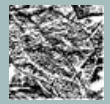
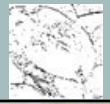
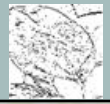
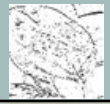
Example of test images

Label	bright	dark
CG		
CJ		

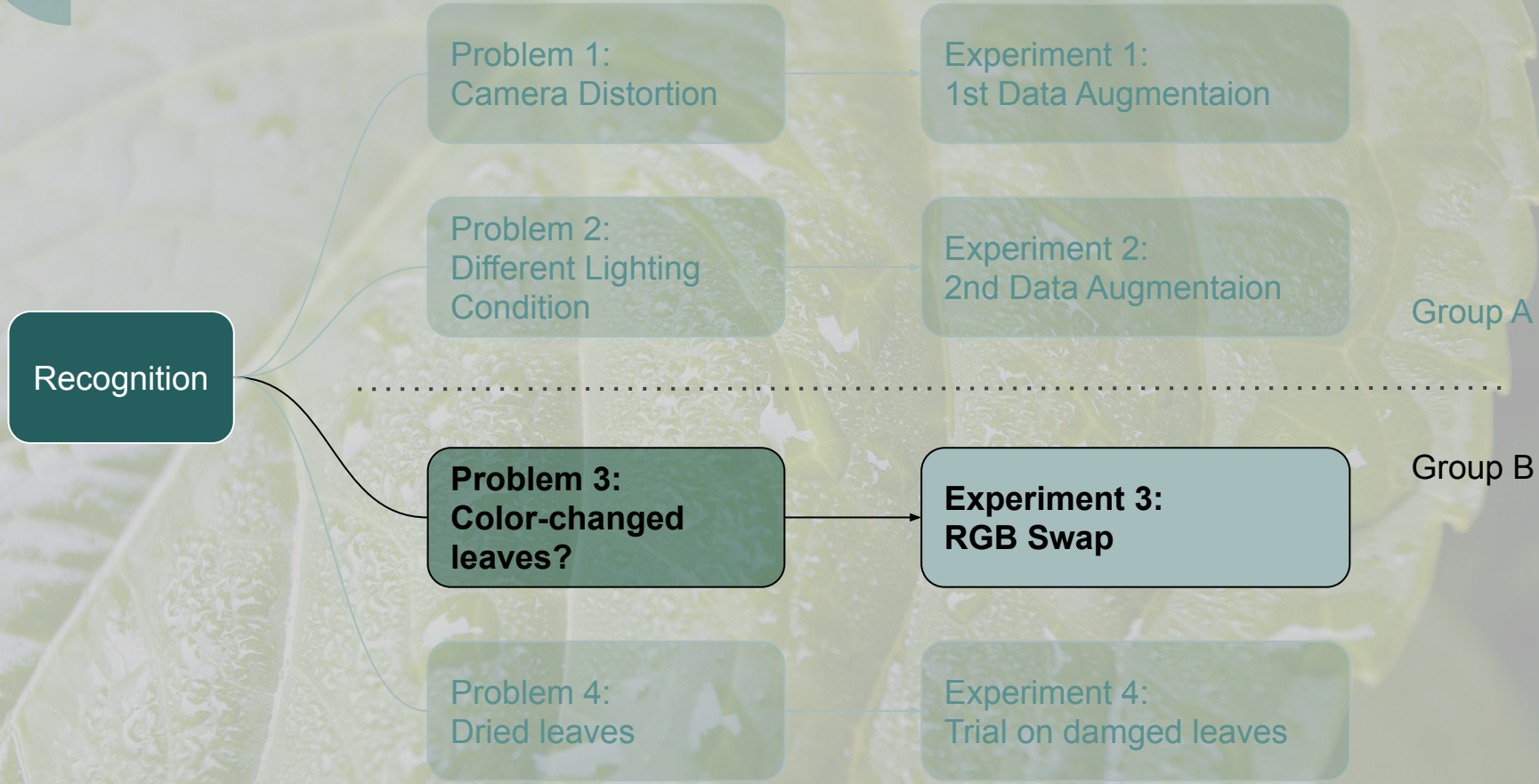
Result

Column:	1	2		3		
File name	Score from model retrained with 1st augmented data	Score from model retrained with augmentation with set 1 variable	Net Result (Col: 2-1)	Score from model retrained with augmentation with set 2 variable	Net Result (Col: 3-1)	Net Result (Col: 3-2)
bv_bright.jpg	0.99952	0.99925	-0.00027	0.99987	0.00035	0.00062
bv_dark.jpg	0.99715	0.99834	0.00119	0.99957	0.00242	0.00123
ca_bright.jpg	0.24871	0.5896	0.34089	0.5528	-0.16704	-0.50793
ca_dark.jpg	0.3984	0.59977	0.20137	0.43227	-0.08022	-0.28159
cb_bright.jpg	0.95536	0.88185	-0.07351	0.93211	-0.02325	0.05026
cb_dark.jpg	0.99997	0.99972	-0.00025	0.99996	-1E-05	0.00024
cg_bright.jpg	0.98583	0.99535	0.00952	0.99438	0.00855	-0.00097
cg_dark.jpg	0.99975	0.99981	6E-05	0.99973	-2E-05	-8E-05
cj_bright.jpg	0.9998	0.99997	0.00017	0.99982	2E-05	-0.00015
cj_dark.jpg	0.99809	0.99906	0.00097	0.99671	-0.00138	-0.00235
fa_bright.jpg	0.97914	0.98521	0.00607	0.97855	-0.00059	-0.00666
fa_dark.jpg	0.86202	0.87345	0.01143	0.54897	-0.31305	-0.32448
hc_bright.jpg	0.99972	0.9958	-0.00392	0.99956	-0.00016	0.00376
hc_dark.jpg	0.99984	0.99989	5E-05	0.99953	-0.00031	-0.00036
hr_bright.jpg	0.9924	0.91952	-0.07288	0.88863	-0.10377	-0.03089
hr_dark.jpg	0.99737	0.99214	-0.00523	0.99895	0.00158	0.00681
mc_bright.jpg	0.94465	0.97052	0.02587	0.95077	0.00612	-0.01975
mc_dark.jpg	0.48928	0.32452	-0.16476	0.71835	0.22907	0.39383
sl_bright.jpg	0.87673	0.95879	0.08206	0.50232	-0.37441	-0.45647
sl_dark.jpg	0.86204	0.93595	0.07391	0.48486	-0.37718	-0.45109
AVERAGE	0.8792885	0.9009255	0.021637	0.85483	-0.0304	-0.0460955

Visualization

	Set 1		Set 2	
Image / Index				
3				
7				
10				
13				

Problem 3


Recognition
Problem 1:
Camera Distortion
Experiment 1:
1st Data Augmentaion
Problem 2:
Different Lighting
Condition
Experiment 2:
2nd Data Augmentaion
Group A
Problem 3:
Color-changed
leaves?
Experiment 3:
RGB Swap
Group B
Problem 4:
Dried leaves
Experiment 4:
Trial on damged leaves

Specification

BGR

Gray

RGB

RGB

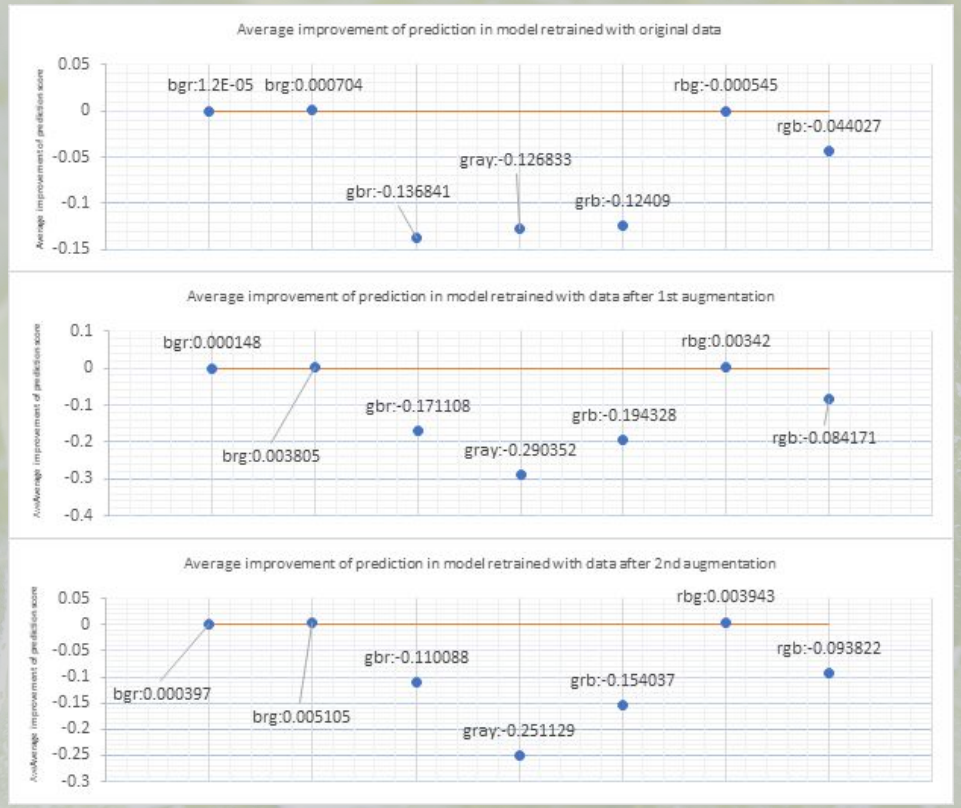
GRB

RBG

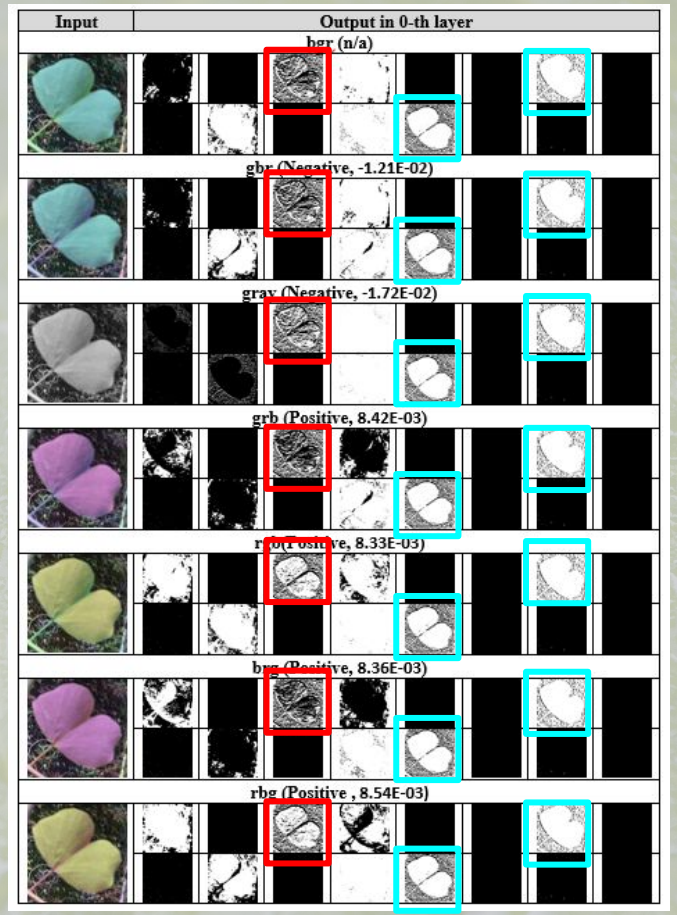
BRG

GBR

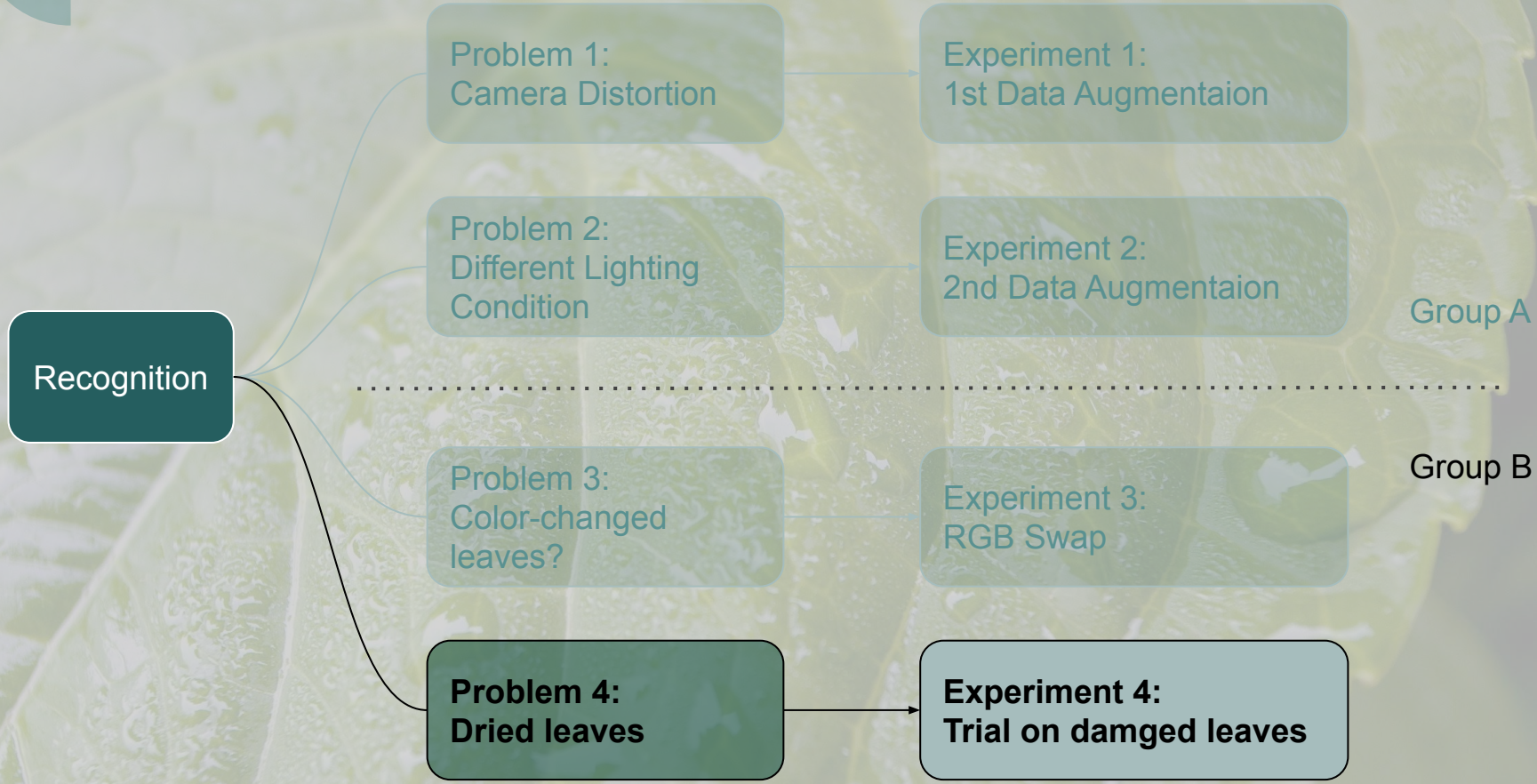
Result


Average improvement of prediction in model retrained with original data
0.05
0
-0.05
-0.1
-0.15
bgr:1.2E-05
brg:0.000704
rbg:-0.000545
rgb:-0.044027
gray:-0.126833
gbr:-0.136841
grb:-0.12409
Average improvement of prediction in model retrained with data after 1st augmentation
0.1
0
-0.1
-0.2
-0.3
-0.4
bgr:0.000148
rbg:0.00342
gbr:-0.171108
grb:-0.194328
brg:0.003805
gray:-0.290352
rgb:-0.084171
Average improvement of prediction in model retrained with data after 2nd augmentation
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
rbg:0.003943
rgb:-0.093822
gbr:-0.110088
grb:-0.154037
bgr:0.000397
brg:0.005105
gray:-0.251129

Visualization



Problem 4


Recognition
Problem 1:
Camera Distortion
Experiment 1:
1st Data Augmentaion
Problem 2:
Different Lighting
Condition
Experiment 2:
2nd Data Augmentaion
Group A
Problem 3:
Color-changed
leaves?
Experiment 3:
RGB Swap
Group B
Problem 4:
Dried leaves
Experiment 4:
Trial on damged leaves

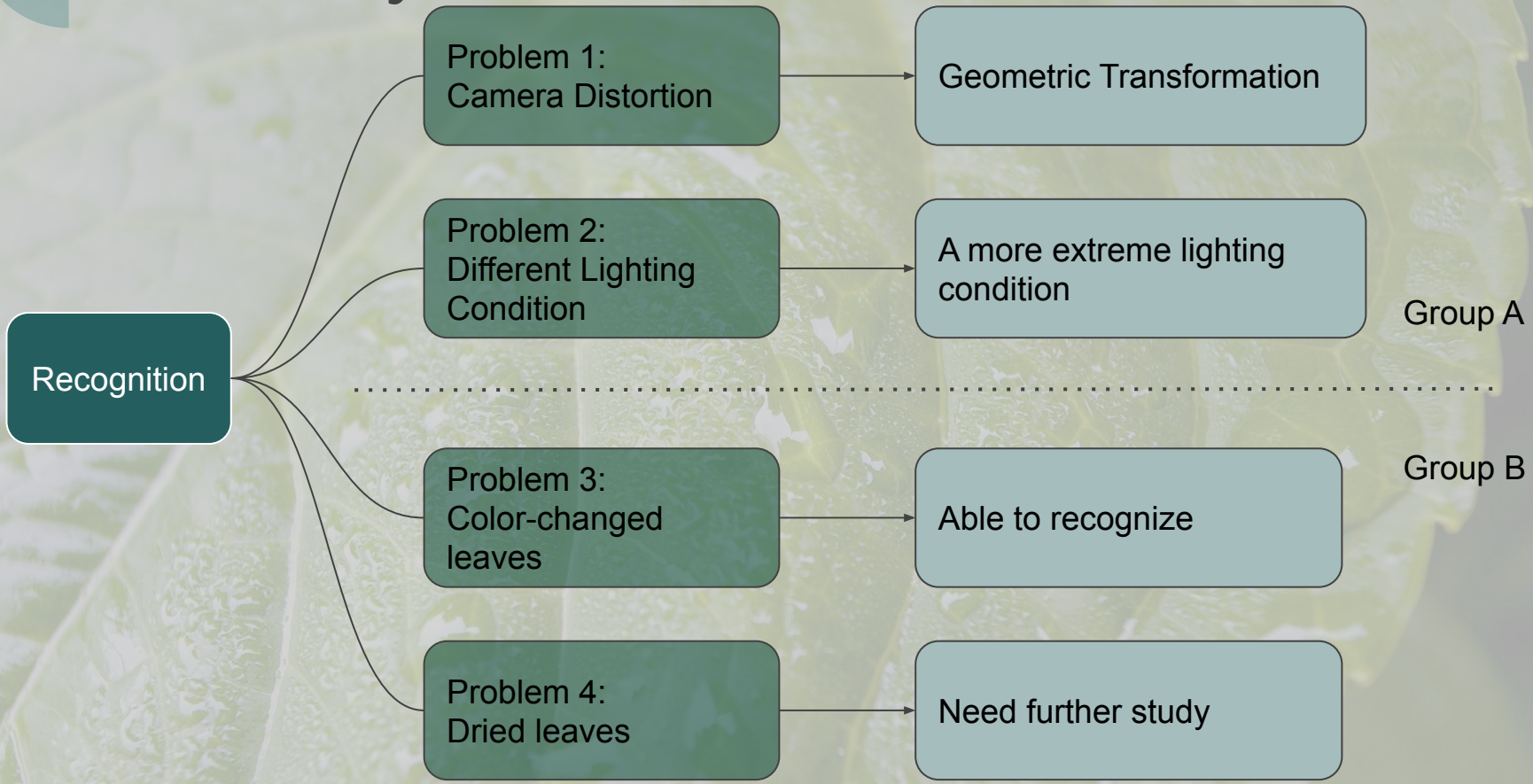
Specification

Result

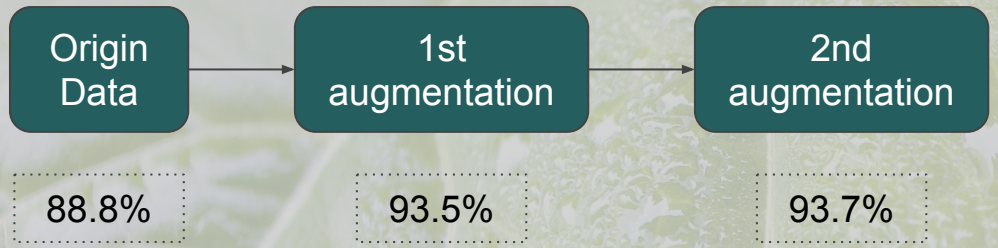
File name	Top 1		Top 2		Top 3		Top 4		Top 5	
	label	score	label	score	label	score	label	score	label	score
Predict with model retrained with origin dataset										
bv00011_dried_1.jpg	bv	0.99253	hc	0.00488	cg	0.00234	cj	0.00023	hr	0.00002
bv00011_dried_2.jpg	hr	0.45673	bv	0.39715	hc	0.12549	cj	0.0142	cg	0.00639
bv00011_dried_3.jpg	hc	0.91146	bv	0.08575	cg	0.00164	cj	0.00106	cb	0.00009
bv00011_dried_4.jpg	cg	0.48314	bv	0.18468	hc	0.14797	cb	0.09793	sl	0.04912
Predict with model retrained with 1st augmented data										
bv00011_dried_1.jpg	bv	0.99859	cj	0.0008	hc	0.00041	hr	0.00013	cg	0.00006
bv00011_dried_2.jpg	hr	0.88454	hc	0.07329	bv	0.02618	cj	0.01586	cg	0.00013
bv00011_dried_3.jpg	hc	0.9984	cj	0.0008	bv	0.00068	cg	0.0001	cb	0.00001
bv00011_dried_4.jpg	bv	0.90092	cb	0.07039	sl	0.01974	hc	0.00379	hr	0.00316
Predict with model retrained with 2nd augmented data										
bv00011_dried_1.jpg	bv	0.99993	cj	0.00005	fa	0.00001	hc	0.00001	cg	0.00001
bv00011_dried_2.jpg	bv	0.99984	hr	0.00015	cj	0.00001	fa	0	hc	0
bv00011_dried_3.jpg	bv	0.8279	hc	0.13363	cj	0.02803	cg	0.01014	fa	0.00025
bv00011_dried_4.jpg	bv	0.97029	hc	0.00771	cg	0.00762	cb	0.00672	hr	0.00365

Visualization

Summary


Recognition
Problem 1:
Camera Distortion
Geometric Transformation
Problem 2:
Different Lighting
Condition
A more extreme lighting
condition
Group A
Problem 3:
Color-changed
leaves
Able to recognize
Group B
Problem 4:
Dried leaves
Need further study

The Model we use in the application



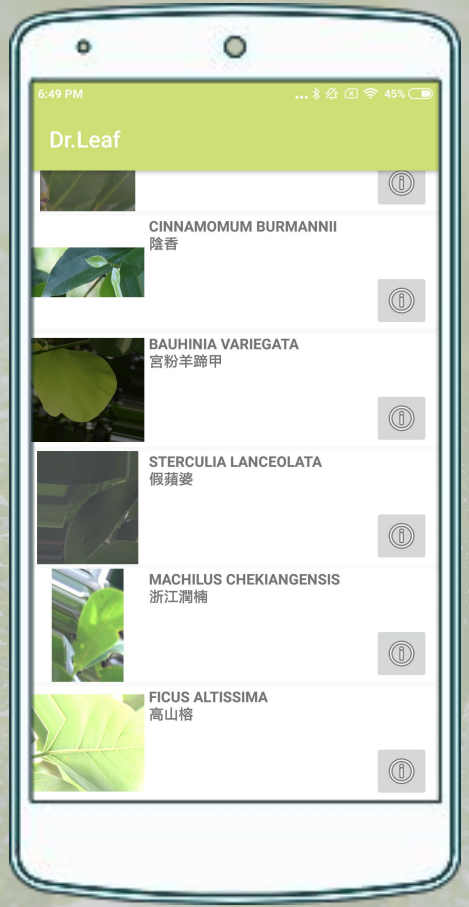
Label	Origin	1st Augmentation	2nd Augmentation
BV	138	799	3991
CA	137	808	3966
CB	140	806	4026
CG	182	1055	5271
CJ	261	1467	7331
FA	209	1194	5966
HC	254	1437	7181
HR	158	912	4556
MC	209	1204	6016
SL	231	1316	6576
Total	1919	10998	54880


Continue
demo...

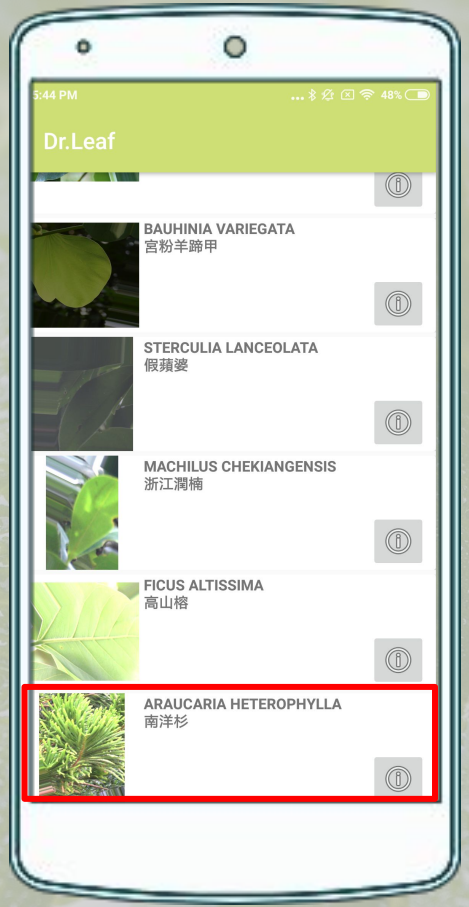

5:43 PM
48%
Dr.Leaf
DEMO
UPDATE
STEP 1
Take a photo of the leaf
STEP 2
Classify it!
85%
TAKE A PHOTO
CLASSIFY


5:44 PM
48%
Dr.Leaf
Map
All
STEP 1
Take a photo of the leaf
STEP 2
Classify it!
85%
TAKE A PHOTO
CLASSIFY

Before

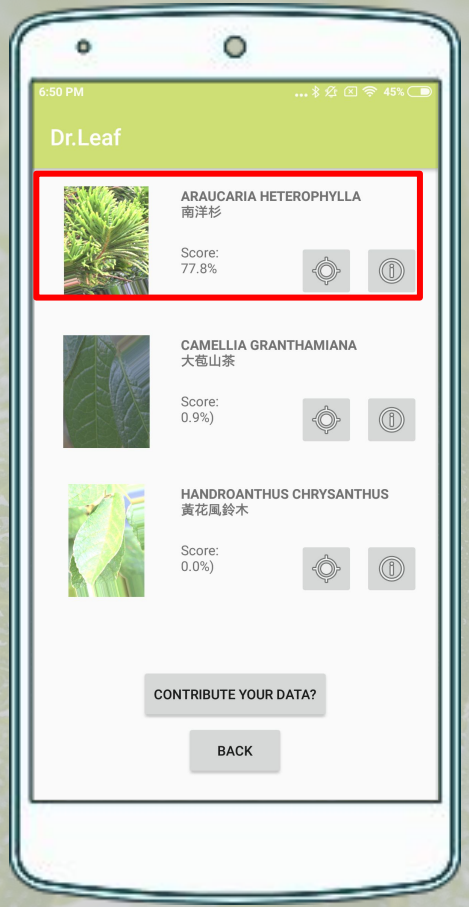

6:49 PM
45%
Dr.Leaf
CINNAMOMUM BURMANNII
陰香
BAUHINIA VARIEGATA
宮粉羊蹄甲
STERCULIA LANCEOLATA
假蘋婆
MACHILUS CHEKIANGENSIS
浙江潤楠
FICUS ALTISSIMA
高山榕

After


5:44 PM
48%
Dr.Leaf
BAUHINIA VARIEGATA
宮粉羊蹄甲
STERCULIA LANCEOLATA
假蘋婆
MACHILUS CHEKIANGENSIS
浙江潤楠
FICUS ALTISSIMA
高山榕
ARAUCARIA HETEROPHYLLA
南洋杉

Possible Outcome

- if
  - Quality of dataset is great
  - Size of dataset is big
- then
  - Improved Outcome


6:50 PM
45%
Dr.Leaf
ARAUCARIA HETEROPHYLLA
南洋杉
Score:
77.8%
CAMELLIA GRANTHAMIANA
大苞山茶
Score:
0.9%)
HANDROANTHUS CHRYSANTHUS
黃花風鈴木
Score:
0.0%)
CONTRIBUTE YOUR DATA?
BACK

Possible Outcome

- if
  - Quality of dataset are great
  - Size of dataset are big
- then
  - Improved Outcome

Pre-trained Model


Thank You

Q&A