Assignment 02 - Report

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Objective

Q1. Consider Fig.1 and remove the larger object from the image. [Hint: Create a mask and apply arithmetic operation].

Q2. Consider Fig.2, and find out whether the person has moved his hand from (a) to (b). You can find out the percentage of change in pixels between them. Can you solve the problem with any other method?

Q3.

A. Load the image shown in Fig.3. Examine the distinct intensity levels that the image has. Consider each of the intensity levels as a random variable, and compute the probabilities of each of the intensity levels.
B. Plot the computed probabilities with respect to the intensity levels.
C. Now, add constant value 100 with the image of Fig.3, and plot the probabilities with respect to the intensity levels.
D. Observe the difference between two plots.
E. What kind of arithmetic operation on the image would shift the probability distribution towards the left?
F. If you downsample the given image by a factor 2, and plot the probability distribution – what will happen? Explain your observation.

Q4. Implement an algorithm to find out the number plate of Fig.4(a) within the image (Fig. 4(b)). [Hint: Use the image matching algorithm and find out the normalized cross-correlation for each pixel].

Methods and Experiments

Q1. Consider Fig.1 and remove the larger object from the image. [Hint: Create a mask and apply arithmetic operation].

Method used:

There are two methods for removal of any object from the image:

1. Arithmetic Operations
   Step1. Create a mask according to our region of interest that closely fits the large object of the image.
   Step 2. Subtract the mask (created in step 1) from the original image.

2. Bitwise Operations
   Step1. Create a mask that covers all the image points except the large object of the image.
   Step 2. Perform bitwise 'AND' operation between the mask (created in step 1) and the original image.

Q2. Consider Fig.2, and find out whether the person has moved his hand from (a) to (b). You can find out the percentage of change in pixels between them. Can you solve the problem with any other method?

Method used:

% change of pixels = $\frac{I2 - I1}{Total\ pixel\ count}\ X\ 100$

We used image subtraction to find out the difference between the two images. We subtracted the original image (a) from the final image (b), to get the changed pixels.

Another method to detect the slight difference between two images is "Image Registration's Image Matching Step". (Results of image matching are present in observation section)

Q3.

A. Load the image shown in Fig.3. Examine the distinct intensity levels that the image has. Consider each of the intensity levels as a random variable, and compute the probabilities of each of the intensity levels.
B. Plot the computed probabilities with respect to the intensity levels.
C. Now, add constant value 100 with the image of Fig.3, and plot the probabilities with respect to the intensity levels.
D. Observe the difference between two plots.
E. What kind of arithmetic operation on the image would shift the probability distribution towards the left?
F. If you downsample the given image by a factor of 2, and plot the probability distribution – what will happen? Explain your observation.

Methods used:

We created ***generatehistogram()*** to create a dictionary where keys are the intensity level and values represent the count of pixels having corresponding intensity level (as the 'key').

To compute the probability of each intensity level, the values of the dictionary are divided by the total pixel count.

$$Prob\ (intensity\ level\ i)\ = \frac{hist[i]}{Total\ pixel\ count}$$

Next, we plotted different plots by adding a constant 100 to each pixel intensity.

The following plots are generated:

- Intensity vs pixel count (original Image)
- Intensity vs Probability (original Image)
- Intensity vs pixel count (when 100 is added)
- Intensity vs Probability (when 100 is added)
- Intensity vs pixel count (when 110 is subtracted)
- Intensity vs Probability (when 110 is subtracted)
- Intensity vs pixel count (image_Q3_downsampled)
- Intensity vs Probability (image_Q3_downsampled)

Q4. Implement an algorithm to find out the number plate of Fig.4(a) within the image (Fig. 4(b)). [Hint: Use the image matching algorithm and find out the normalized cross-correlation for each pixel].

Methods used:

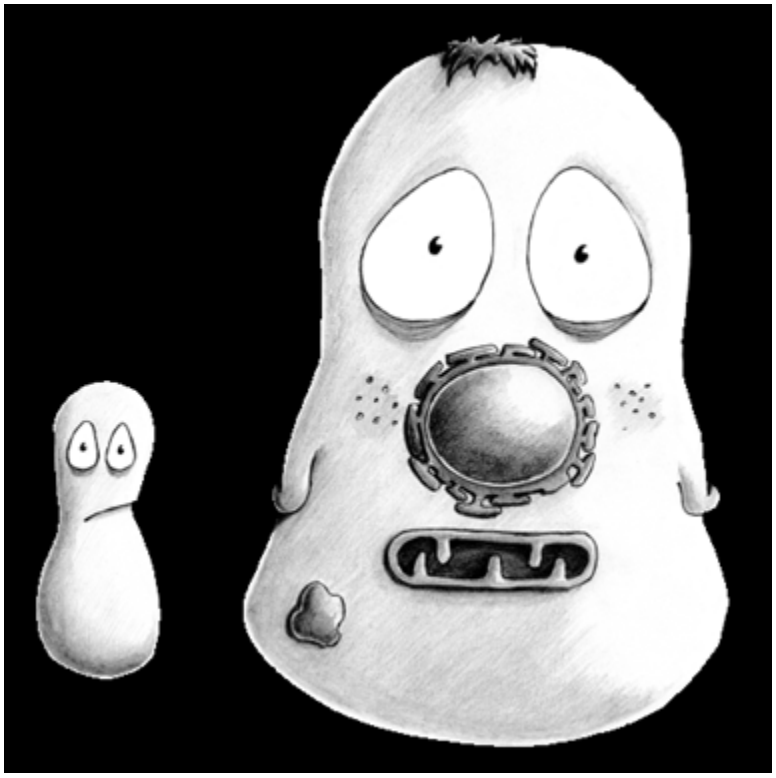
We have taken the required number plate image (plate.jpg) as a template. We further converted both the original image and the template image to grayscaled images. After that, we silded the template on the original image to find the similarity value (normalized cross-correlation) for each pixel. We further found the indices for the region having max similarity value.

We used these indices and the length and width of the template image to draw the rectangle around the matched region.

Observations

Q1. Consider Fig.1 and remove the larger object from the image. [Hint: Create a mask and apply arithmetic operation].

Q1 Image



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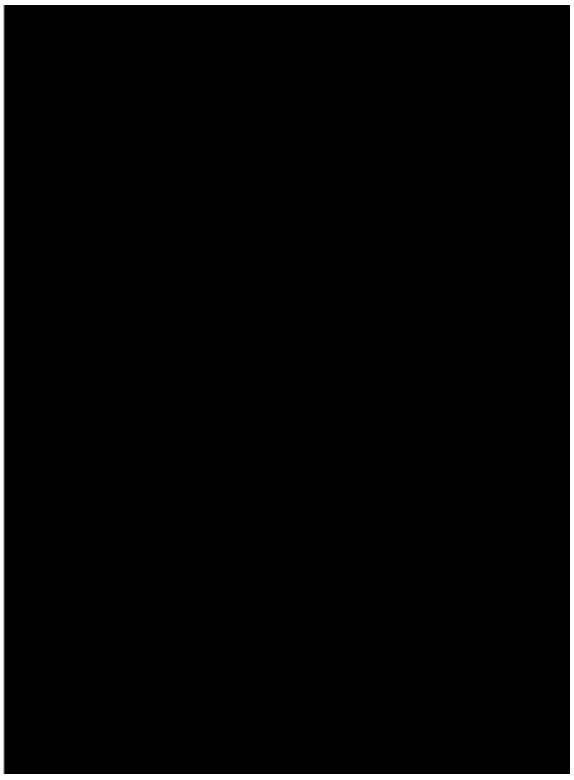
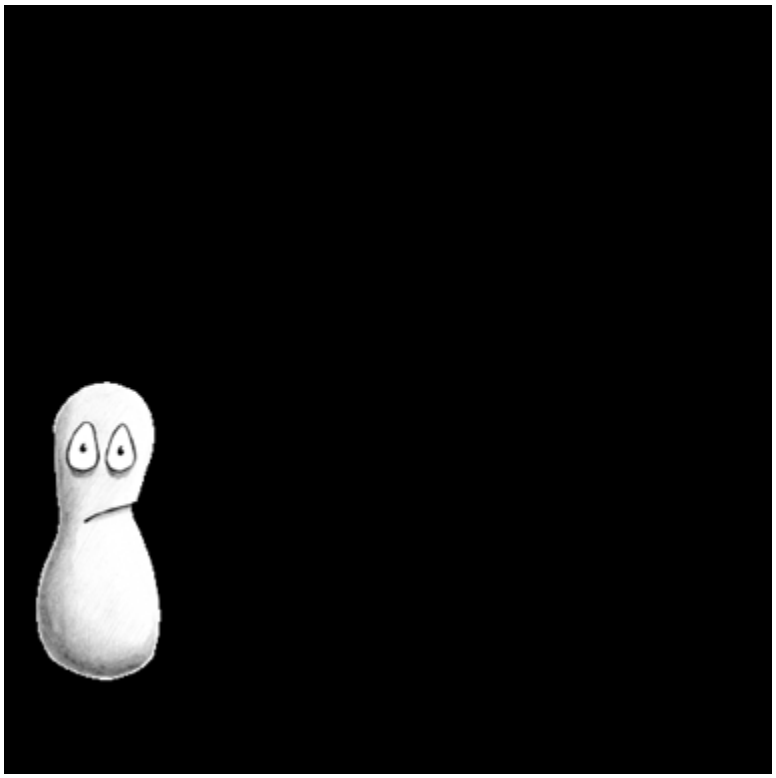
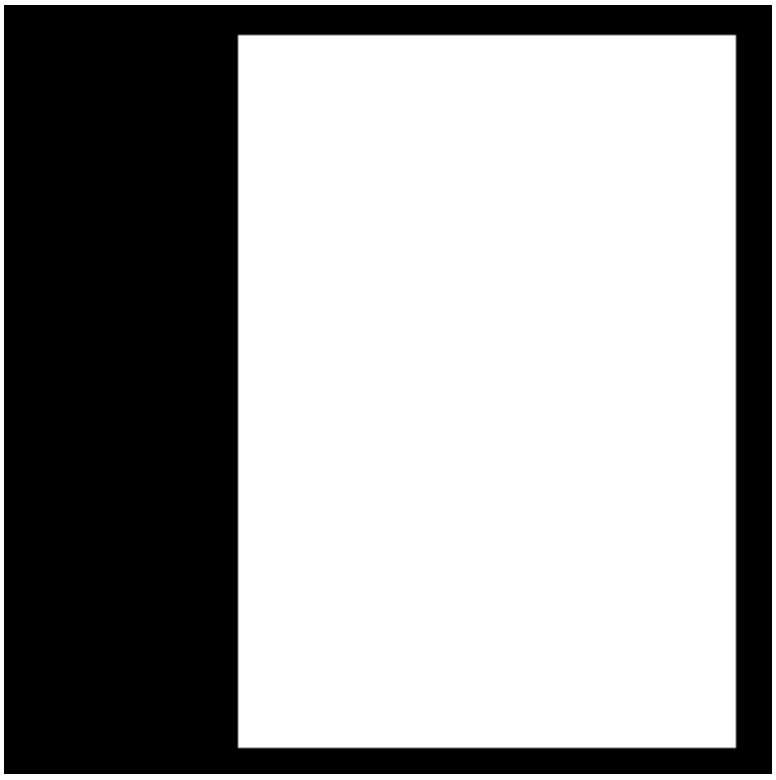
METHOD 1 - Bitwise Operations
Mask M1



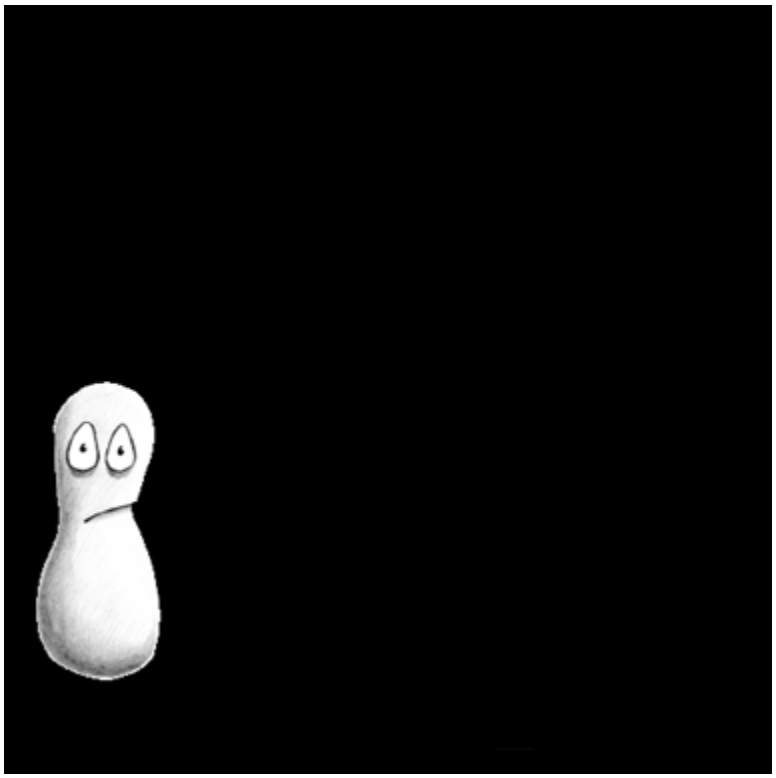
Resultant Image from Method 1



METHOD 2 - Arithmetic Operations
Mask M2



Resultant Image from Method 2

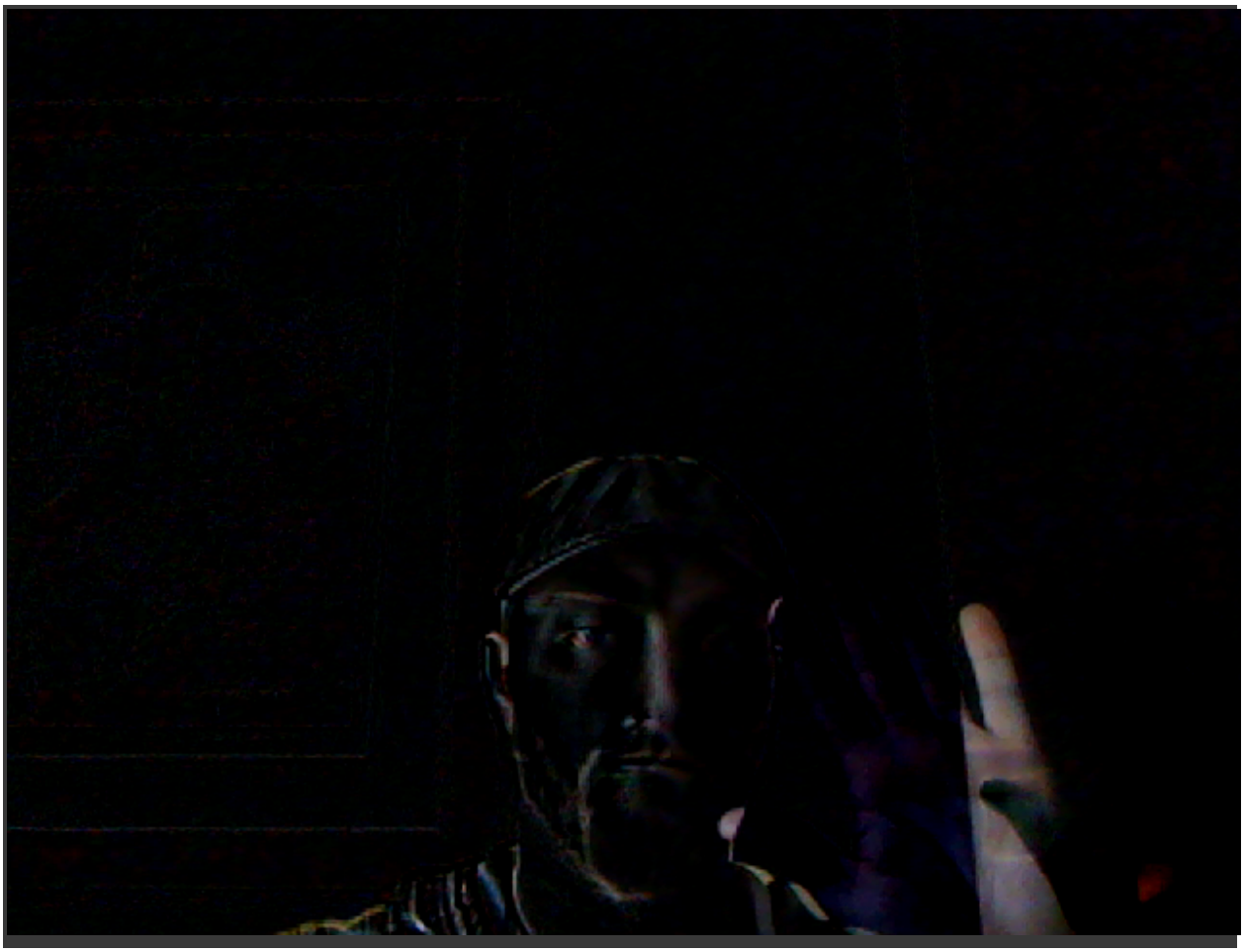


Q2. Consider Fig.2, and find out whether the person has moved his hand from (a) to (b). You can find out the percentage of change in pixels between them. Can you solve the problem with any other method?

image_Q2_A

image_Q2_B

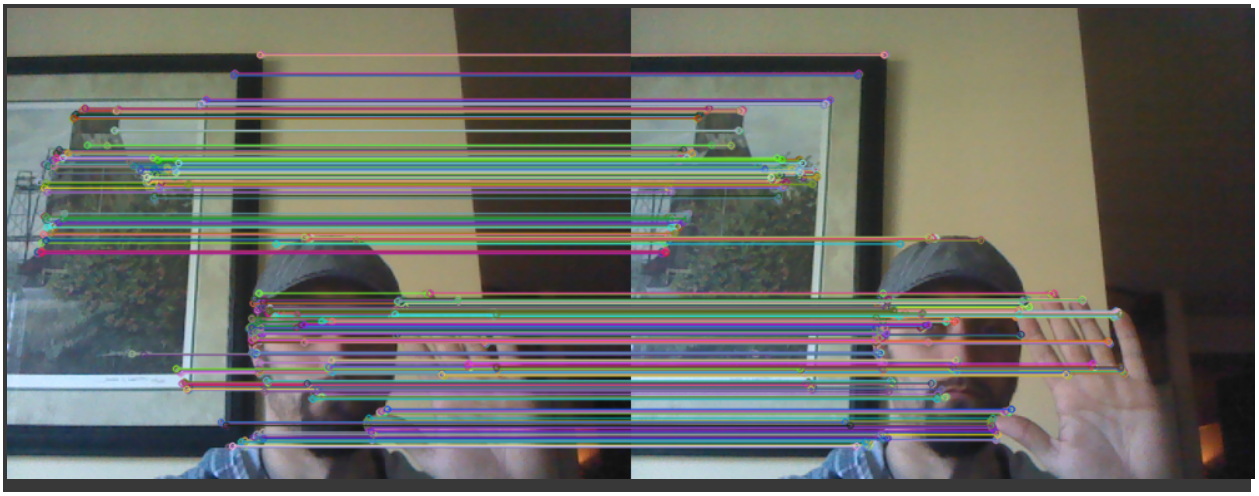
Subtraction Image A - Image B



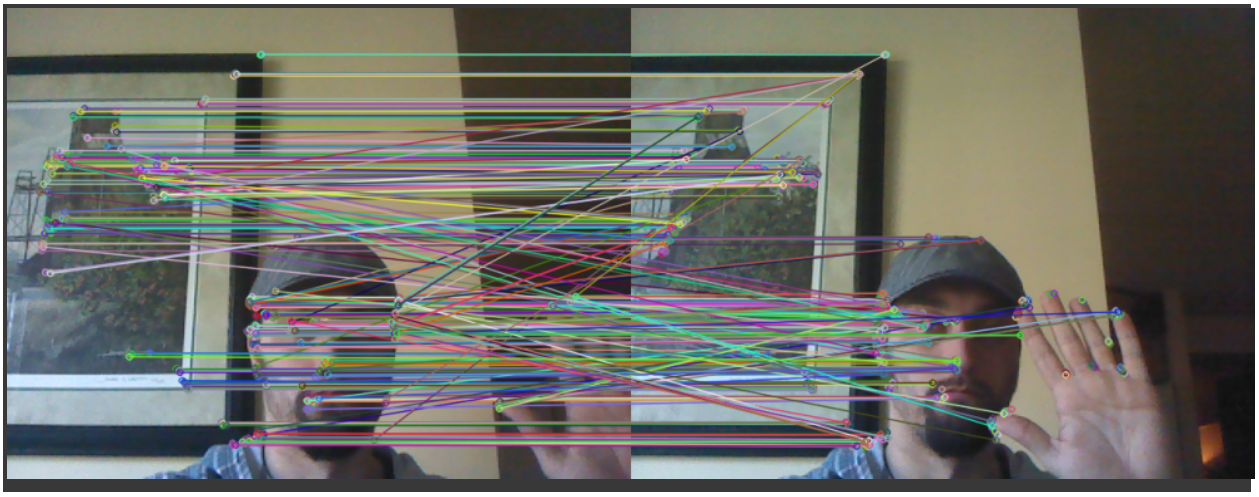
No. of changed pixels : 184053
Total no. of pixels in image : 307200
Percentage change in pixels : 59.9130859375
==========

Image Registration's Matching Step : This is required in order to be able to compare or integrate the data obtained from these different images.

Matched Keypoints : When 2 images are same



Matched Keypoints : When 2 images are slightly different



Q3.

Load the image shown in Fig.3. Examine the distinct intensity levels that the image has. Consider each of the intensity levels as a random variable, and compute the probabilities of each of the intensity levels.
Plot the computed probabilities with respect to the intensity levels.
Now, add constant value 100 with the image of Fig.3, and plot the probabilities with respect to the intensity levels.
Observe the difference between two plots.

What kind of arithmetic operation on the image would shift the probability distribution towards the left?
If you downsample the given image by a factor 2, and plot the probability distribution – what will happen? Explain your observation.

A. ==========
image_Q3

total no. of pixels ; 383877

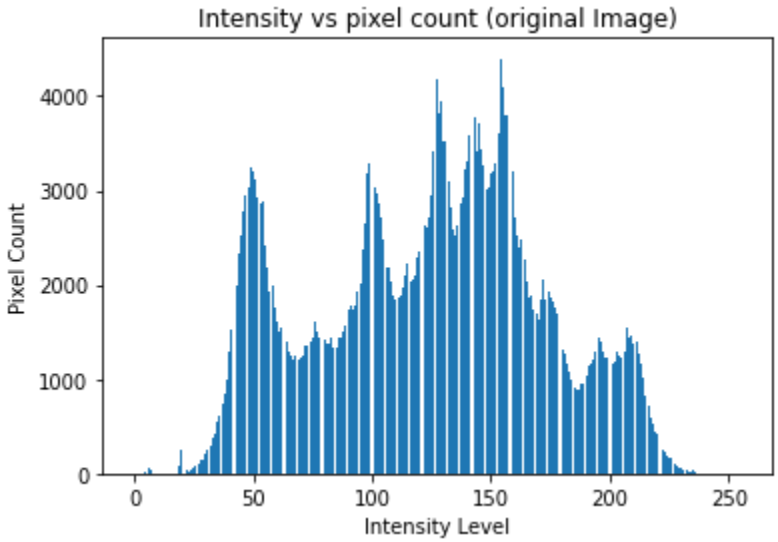
Probabilty At Each Intensity Level :

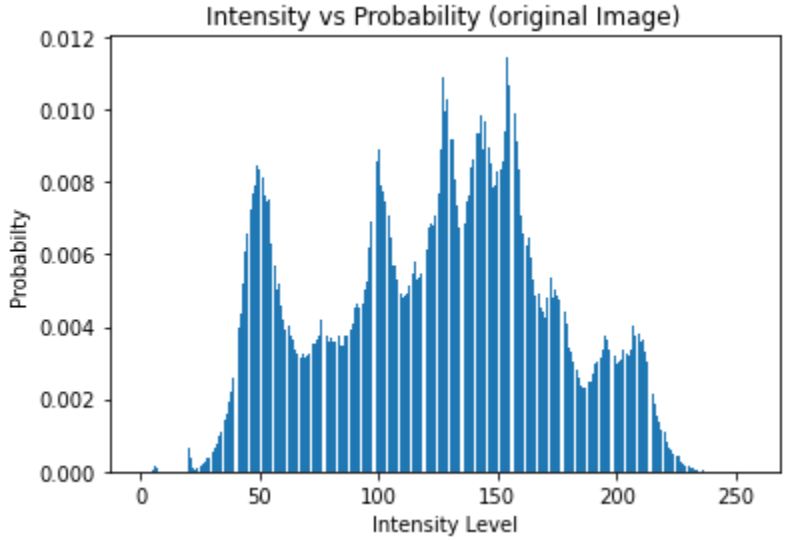
[(0, 0.0), (1, 0.0), (2, 0.0), (3, 2.6050010810754487e-06), (4, 7.815003243226346e-06), (5, 4.949502054043352e-05), (6, 0.00016151006702667782), (7, 9.63850399997916e-05), (8, 1.3025005405377243e-05), (9, 7.815003243226346e-06), (10, 0.0), (11, 2.6050010810754487e-06), (12, 7.815003243226346e-06), (13, 0.0), (14,

2.6050010810754487e-06), (15, 7.815003243226346e-06), (16, 2.6050010810754487e-06), (17, 1.0420004324301795e-05), (18, 1.0420004324301795e-05), (19, 0.0001849550767563568 5), (20, 0.0006642752756742394), (21, 0.0003647001513505628), (22, 8.857003675656525e-05), (23, 7.033502918903712e-05), (24, 9.899004108086705e-05), (25, 0.0001458800605402 2513), (26, 0.000203190084323885), (27, 0.000255290105945394), (28, 0.0003673051524316383), (29, 0.0003907501621613173), (30, 0.0005392352237826179), (31, 0.0006746952799985412), (32, 0.0007815003243226346), (33, 0.0009664554010789915), (34, 0.001120150464862443), (35, 0.0014301455935104212), (36, 0.0015838406572938727), (37, 0.001899045788104002), (38, 0.0021882009081033767), (39, 0.002589371074588996), (40, 0.003373476399992706), (41, 0.003954391641072531), (42, 0.004381611818368904), (43, 0.005186557152421 2185), (44, 0.006054022512419342), (45, 0.0065828377318776585), (46, 0.007234088002146521), (47, 0.007656098177280744), (48, 0.007880128270253231), (49, 0.008432388499441227), (50, 0.008338608460522512), (51, 0.008140628378360777), (52, 0.007632653167551065), (53, 0.007481563104848689), (54, 0.007510218116740518), (55, 0.006306707617283661), (56, 0.005671087353501252), (57, 0.005040677091880993), (58, 0.005189162153502294), (59, 0.004561356892963 1105), (60, 0.004186236737288246), (61, 0.003923131628099626), (62, 0.004055986683234 4735), (63, 0.003753806557829 7214), (64, 0.003654816516748 8546), (65, 0.003391711407560234), (66, 0.003240621344857858), (67, 0.003154656309182368), (68, 0.003235411342695 7074), (69, 0.003118186294047312), (70, 0.003198941327560 6508), (71, 0.003248436348101 0844), (72, 0.003534986467019 3836), (73, 0.003506331455127554), (74, 0.003647001513505628), (75, 0.0037433865535054 2), (76, 0.00417842173404502), (77, 0.0038918716151267203), (78, 0.003766831563235 0988), (79, 0.003574061483235 5157), (80, 0.003693891532964 9863), (81, 0.003602716495127 3455), (82, 0.003566246479992 2893), (83, 0.003756411558910797), (84, 0.003482886445397875), (85, 0.003490701448641 1014), (86, 0.00374338655350542), (87, 0.003732966549181118), (88, 0.003923131628099626), (89, 0.004076826691883077), (90, 0.004545726886476658), (91, 0.004613456914584619), (92, 0.004553541889719884), (93, 0.004639506925395374), (94, 0.004998997074583786), (95, 0.005251682179448 1045), (96, 0.006184272566473115), (97, 0.006926697874579618), (98, 0.008281298436738851), (99, 0.008544403545927472), (100, 0.008893473690791581), (101, 0.007924413288631514), (102, 0.007729038207550856), (103, 0.007465933098362236), (104, 0.007080392938363069), (105, 0.006436957671337434), (106, 0.005689322361068 78), (107, 0.005712767370798 4584), (108, 0.005301177199988538), (109, 0.004905217035665 07), (110, 0.004803621993503127), (111, 0.004858327016205712), (112, 0.004918242041070447), (113, 0.005134457130799709), (114, 0.005470502270258442), (115, 0.005819572415122552), (116, 0.005322017208637 1415), (117, 0.005348067219447896), (118, 0.005488737277825 97), (119, 0.005981082482149 23), (120, 0.006111133253620 3003), (121, 0.006723507790255733), (122, 0.006827707833498751), (123, 0.006780817814039393), (124, 0.007051737926471 24), (125, 0.007705593197821177), (126, 0.008922128702683411), (127, 0.010878484514571074), (128, 0.009927659119978534), (129, 0.010271519262680493), (130, 0.009164393803223429), (131, 0.009166998804304504), (132, 0.008085923355658192), (133, 0.007325263039984161), (134, 0.006728717792417883), (135, 0.006601072739445187), (136, 0.006871992851877034), (137, 0.007460723096200085), (138, 0.007624838164307838), (139, 0.008403733487549397), (140, 0.008617343576197584), (141,

0.009333718873493333), (142, 0.009320693868087955), (143, 0.009857324090789498), (144, 0.008922128702683411), (145, 0.009654134006465613), (146, 0.00896901872214277), (147, 0.008502723528630265), (148, 0.007854078259442478), (149, 0.007887943273496458), (150, 0.008273483433495625), (151, 0.008346423463765738), (152, 0.00859129356538683), (153, 0.009401448901601293), (154, 0.011459399755650898), (155, 0.010690924436733642), (156, 0.00990681911132993), (157, 0.009888584103762404), (158, 0.009130528789169447), (159, 0.00833339845836036), (160, 0.007090812942687371), (161, 0.006585442732958734), (162, 0.006220742581608171), (163, 0.00648905769295894 2), (164, 0.005884697442149438), (165, 0.005280337191339935), (166, 0.004871352021611089), (167, 0.004900007033502919), (168, 0.004514466873503753), (169, 0.004438921842152565), (170, 0.00426438676972051), (171, 0.00479059698809775), (172, 0.005355882222691123), (173, 0.004803621993503127), (174, 0.005022442084313465), (175, 0.004853117014043561), (176, 0.0047411019675573166), (177, 0.004597826908098167), (178, 0.004428501837828263), (179, 0.004095061699450606), (180, 0.003409946415127762), (181, 0.003297931368641518), (182, 0.003027011256209671), (183, 0.002810796166480409 3), (184, 0.002612816084318675), (185, 0.00238097098810296), (186, 0.0023366859697246775), (187, 0.002318450962157149), (188, 0.002461726021616299), (189, 0.002479961029183827), (190, 0.002717016127561693), (191, 0.002972306233507087), (192, 0.003027011256209671), (193, 0.003159866311344519), (194, 0.003373476399992706), (195, 0.003738176551343269), (196, 0.003662631519992080 6), (197, 0.0033630563956684044), (198, 0.0031833113210741983), (199, 0.00321196633296602 8), (200, 0.002995751243236766), (201, 0.003040036261615048 5), (202, 0.0031103712908040855), (203, 0.0033422163870198006), (204, 0.003264066354587537), (205, 0.003175496317830972), (206, 0.003376081401073781 4), (207, 0.004027331671342643), (208, 0.0037772515675594007), (209, 0.003831956590261984 8), (210, 0.00360011149404627), (211, 0.003667841522154231 6), (212, 0.003313561375127971), (213, 0.003037431260533973), (214, 0.002620631087561901 3), (215, 0.002169965900535849), (216, 0.001852155768644643 9), (217, 0.001521320631348062), (218, 0.0013780455718889124), (219, 0.001174855487565027 2), (220, 0.0010758654464841603), (221, 0.000844020350268445 3), (222, 0.0006746952799854 12), (223, 0.0005835202421609005), (224, 0.000502765208647561 5), (225, 0.00043764018162067536), (226, 0.000422010175134222 67), (227, 0.0002891551199993748), (228, 0.000213610088648186 78), (229, 0.0001328550551348479), (230, 0.000166720069188828 71), (231, 0.0001250400518916215 4), (232, 0.000101595042161942 5), (233, 5.9915024864735316e-05), (234, 6.773002810796167e-05), (235, 7.815003243226346e-05), (236, 5.210002162150897e-05), (237, 1.5630006486452693e-05), (238, 1.5630006486452693e-05), (239, 7.815003243226346e-06), (240, 2.6050010810754487e-06), (241, 5.210002162150897e-06), (242, 2.6050010810754487e-06), (243, 2.6050010810754487e-06), (244, 0.0), (245, 0.0), (246, 0.0), (247, 0.0), (248, 0.0), (249, 0.0), (250, 0.0), (251, 0.0), (252, 0.0), (253, 0.0), (254, 0.0), (255, 0.0)]

B. ==========





C. ==========

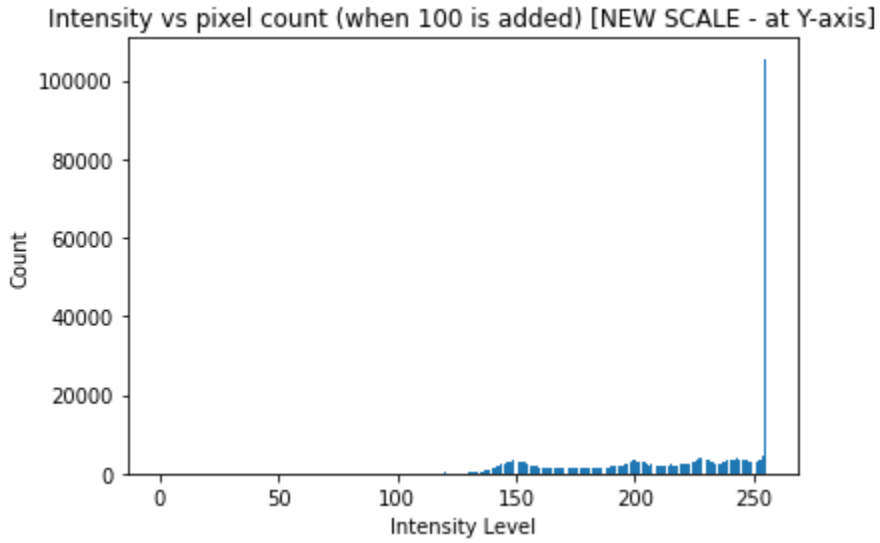
Original Image

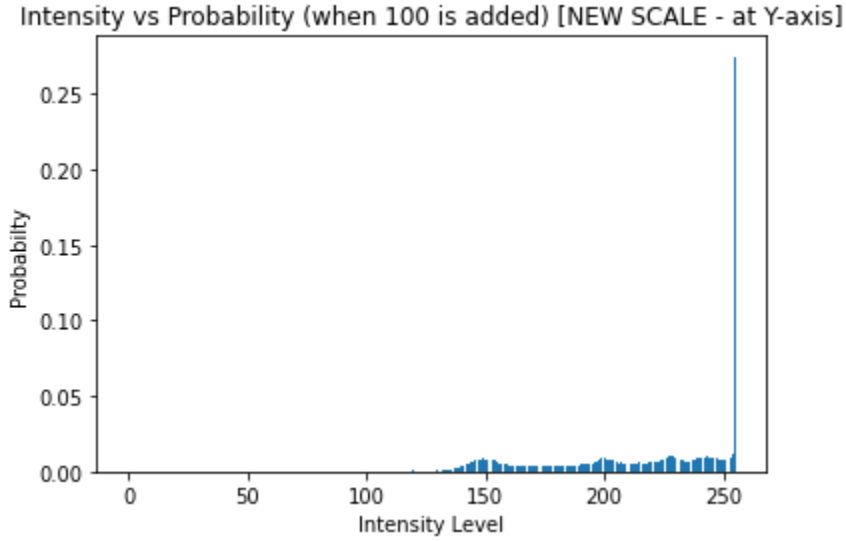
```
[[  6 163 162 ... 143 157 171]
 [  6 163 163 ... 143 156 169]
 [  5 163 163 ... 142 152 161]
 ...
 [  6  48  47 ...  82  87  94]
 [  6  48  47 ...  85  89  95]
 [  6  48  47 ...  86  90  96]]
```

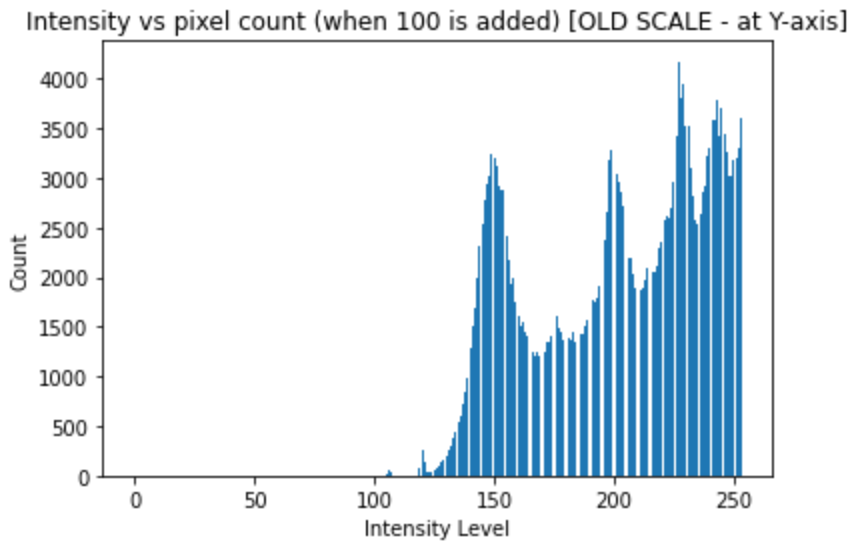
Image when 100 is added

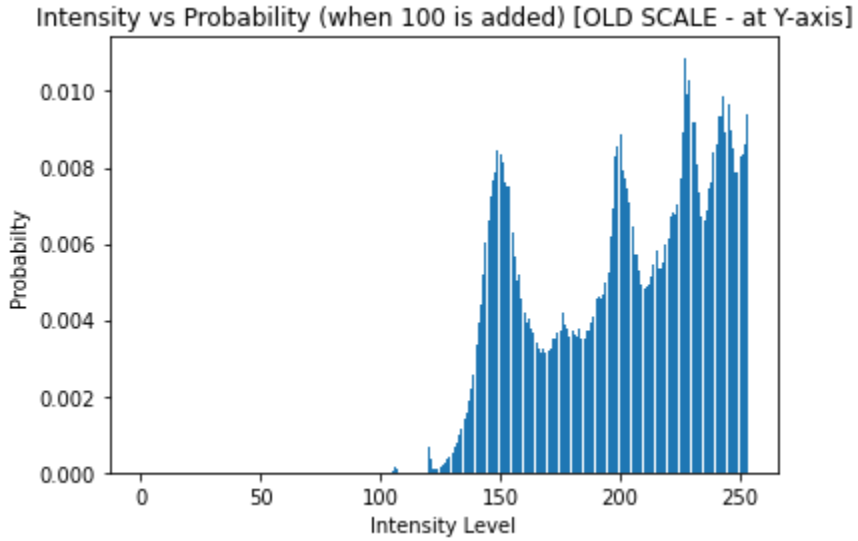
```
[[106 255 255 ... 243 255 255]
 [106 255 255 ... 243 255 255]
```

[105 255 255 ... 242 252 255]
...
[106 148 147 ... 182 187 194]
[106 148 147 ... 185 189 195]
[106 148 147 ... 186 190 196]]









D. ==========

Observation : Histogram shifted to right when a constant 100 is added to all pixel intensities

E. ==========

To shift histogram shifted to left, a constant (E.g. 110) should be subtracted from all pixel intensities

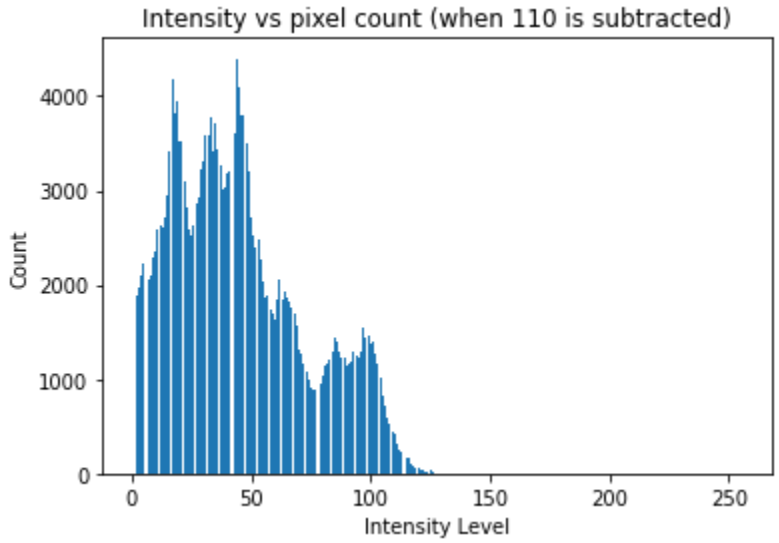
Original Image

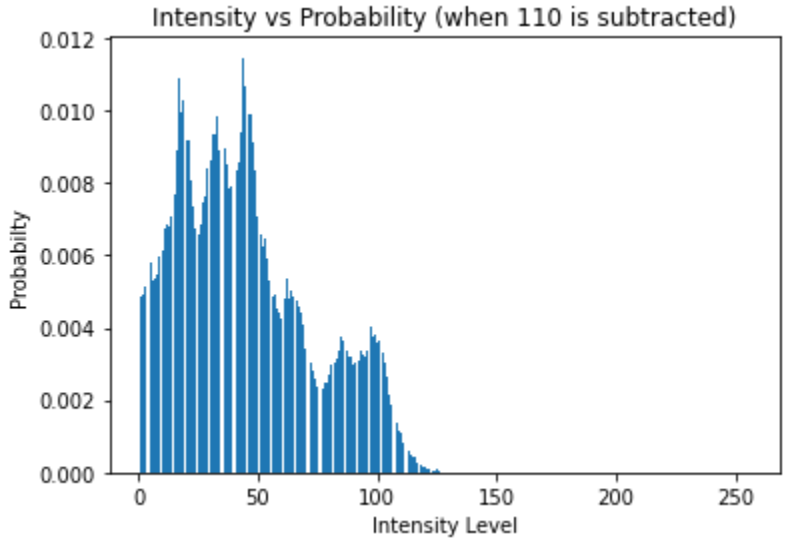
```
[[  6 163 162 ... 143 157 171]
 [  6 163 163 ... 143 156 169]
 [  5 163 163 ... 142 152 161]
 ...
 [  6  48  47 ...  82  87  94]
 [  6  48  47 ...  85  89  95]
```

[6 48 47 ... 86 90 96]]

Image when 110 is subtracted

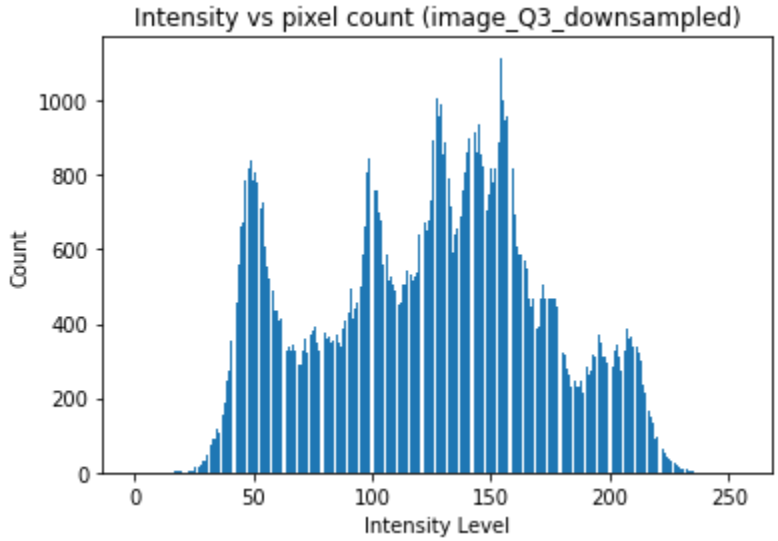
[[0 53 52 ... 33 47 61]
 [0 53 53 ... 33 46 59]
 [0 53 53 ... 32 42 51]
 ...
 [0 0 0 ... 0 0 0]
 [0 0 0 ... 0 0 0]
 [0 0 0 ... 0 0 0]]

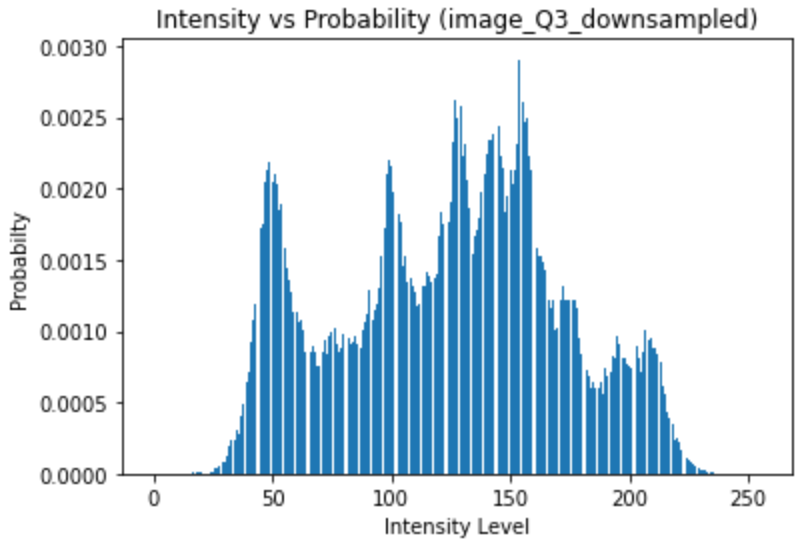




F. ==========
image_Q3_downsampled

Orignal Image size : (579, 663)
image_Q3_downsampled size : (289, 331)





Observation: After downsampling, although the shape of the histogram remains same but height is reduced. (Please check Y-axis scale to spot the difference)

Q4. Implement an algorithm to find out the number plate of Fig.4(a) within the image (Fig. 4(b)). [Hint: Use the image matching algorithm and find out the normalized cross-correlation for each pixel].

We used the following function to draw the rectangle.

```
matplotlib.patches.Rectangle((x_max, y_max), col_f, row_f, edgecolor='r', facecolor="none")
```

Parameter	**Meaning**	**Value**
x_max	X-coordinate of top left corner of rectangle	301
y_max	Y-coordinate of top left corner of rectangle	305
col_f	Width of rectangle	271
row_f	Length of rectangle	74

Conclusion

Question 1:
Takeaway: To remove any object from the image both bitwise and arithmetic operation can be used. The masks for both implementations are different.

Question 2:
Takeaway: To detect slight differences between two images, the image subtraction method can be used. Further, image registration's image matching step could be used for spotting the differences.

Question 3:
Takeaway: Histogram shift to left or right direction if we subtract or add a scaler value to the image intensity values, respectively. Also, the height of the histogram (plotted between pixel count and intensity) is reduced when we downsample the image. But the height of the histogram (plotted between probability and intensity values) remains the same.

Question 4:
Takeaway: Normalized cross-correlation technique can be used to find the similarity between the template and the given image.