

Image Alignment

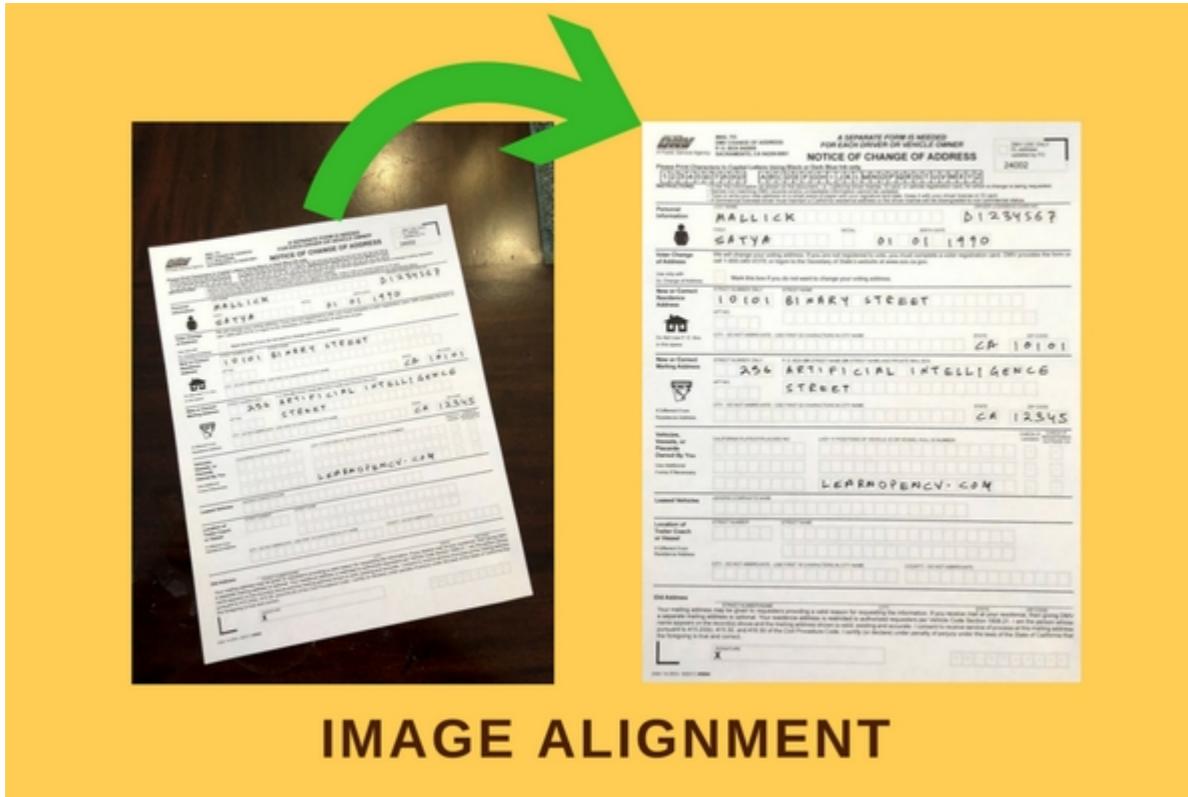
In [1]: #Importing Libraries

```
import cv2
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from PIL import Image
from IPython.display import Image
```

In [2]: alignTemplate = cv2.imread("alignTmplt.jpg", cv2.IMREAD_COLOR)
alignTemplate = cv2.cvtColor(alignTemplate, cv2.COLOR_BGR2RGB)

```
Image(filename = "alignTmplt.jpg")
```

Out[2]:

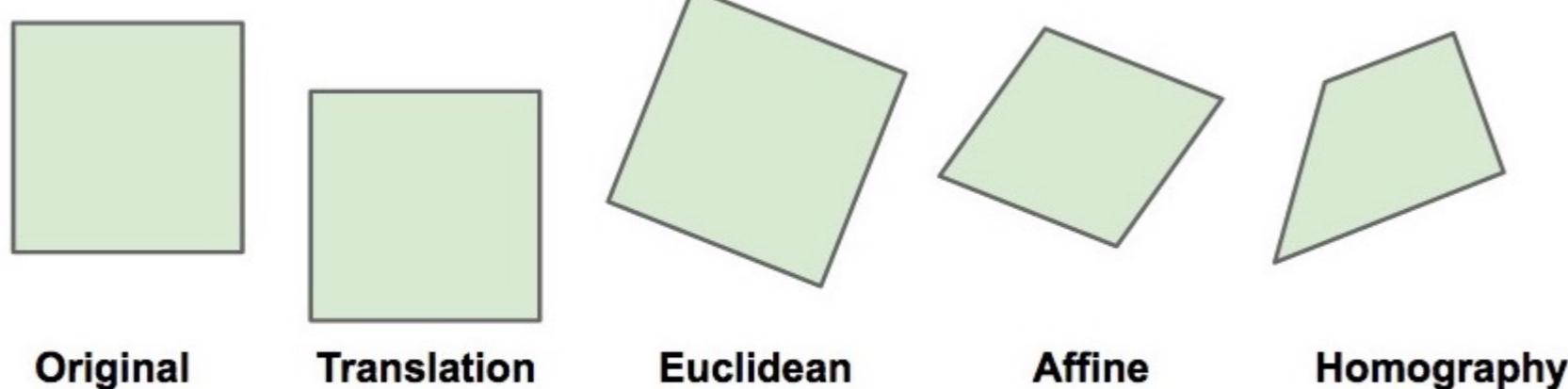


Theory

```
In [3]: theory = cv2.imread("theory.jpg", cv2.IMREAD_COLOR)
theory = cv2.cvtColor(alignTemplate, cv2.COLOR_BGR2RGB)

Image(filename = "theory.jpg")
```

Out[3]:



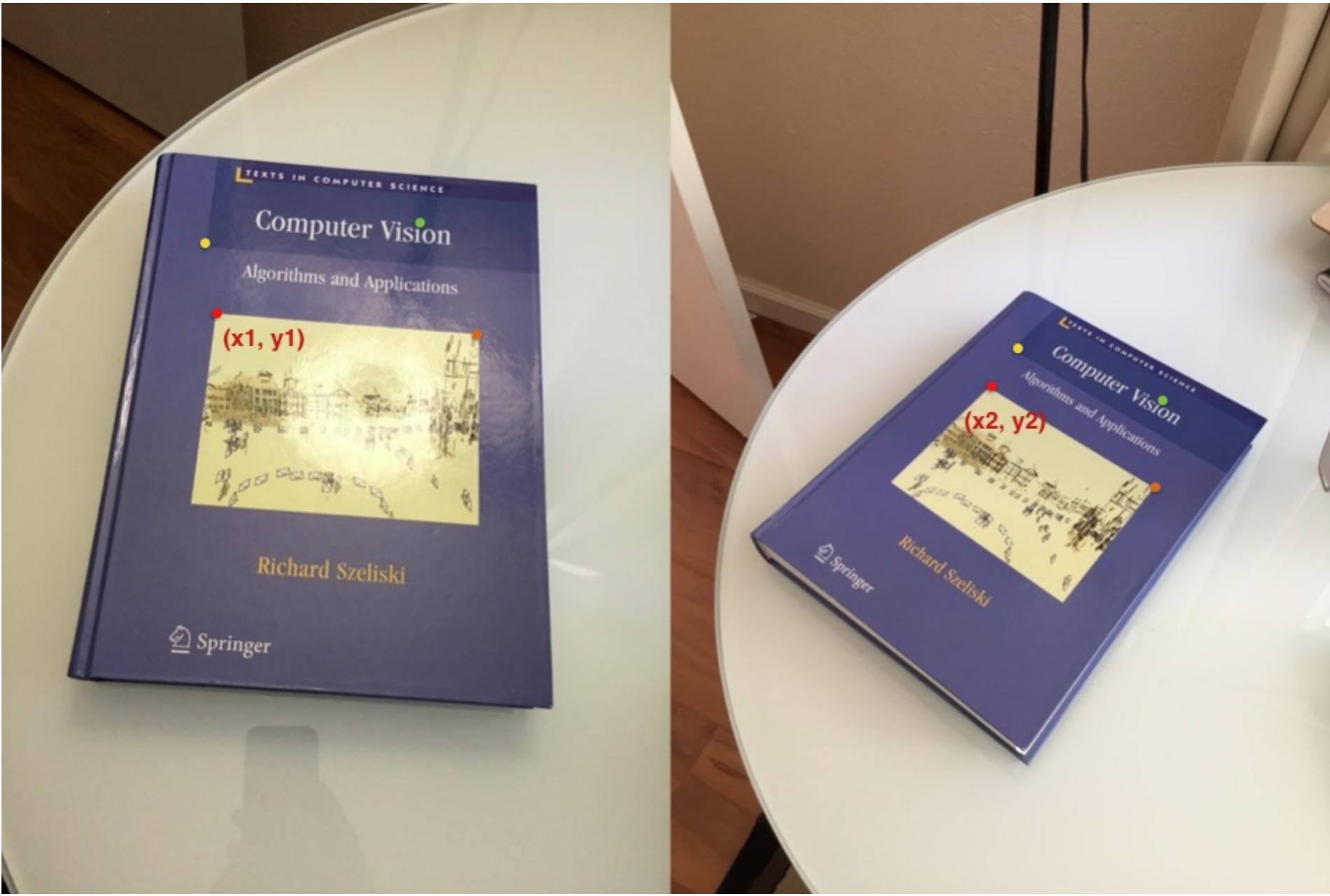
Theory Homography

```
In [4]: #Images of two planes are related by a Homography
#We need 4 corresponding points to estimate Homography
```

```
In [5]: homoGtheory = cv2.imread("theory.jpg", cv2.IMREAD_COLOR)
homoGtheory = cv2.cvtColor(alignTemplate, cv2.COLOR_BGR2RGB)

Image(filename = "homoGtheory.jpg")
```

Out[5]:



```
In [6]: #Step 1 --> Read Template and Scanned Image
```

```
#Read reference image
OriginalForm = "originalForm.png"
print("Reading reference image:", OriginalForm)
OriginalFormImage = cv2.imread(OriginalForm, cv2.IMREAD_COLOR)
OriginalFormImage = cv2.cvtColor(OriginalFormImage, cv2.COLOR_BGR2RGB)

#Read image to be aligned
ScannedForm = "scannedForm.png"
print("Reading image to align:", ScannedForm)
ScannedFormImage = cv2.imread(ScannedForm, cv2.IMREAD_COLOR)
ScannedFormImage = cv2.cvtColor(ScannedFormImage, cv2.COLOR_BGR2RGB)
```

```
Reading reference image: originalForm.png
Reading image to align: scannedForm.png
```

In [7]: #Plotting Images

```
plt.figure(figsize = (20, 10))

plt.subplot(121)
plt.imshow(OriginalFormImage)
plt.axis("off")
plt.title("Original Form", color = "blue")

plt.subplot(122)
plt.imshow(ScannedFormImage)
plt.axis("off")
plt.title("Scanned Form", color = "blue")
```

Out[7]: Text(0.5, 1.0, 'Scanned Form')

Original Form

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1	2	3	4	5	6	7	8	9	0	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

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LAST NAME: DRIVER LICENSE/ID CARD NO.

FIRST: INITIAL: BIRTH DATE:

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Vehicles, Vessels, or Placards Owned By You
CALIFORNIA PLATE/CFI/PLACARD NO.: LAST 17 POSITIONS OF VEHICLE ID OR VESSEL/HULL ID NUMBER:
CHECK IF LEASED CHECK IF REGISTERED OUTSIDE CA

Leased Vehicles
LEASING COMPANY'S NAME:

Location of Trailer Coach or Vessel
STREET NUMBER: STREET NAME:
CITY - DO NOT ABBREVIATE - USE FIRST 16 CHARACTERS IN CITY NAME: COUNTY - DO NOT ABBREVIATE:

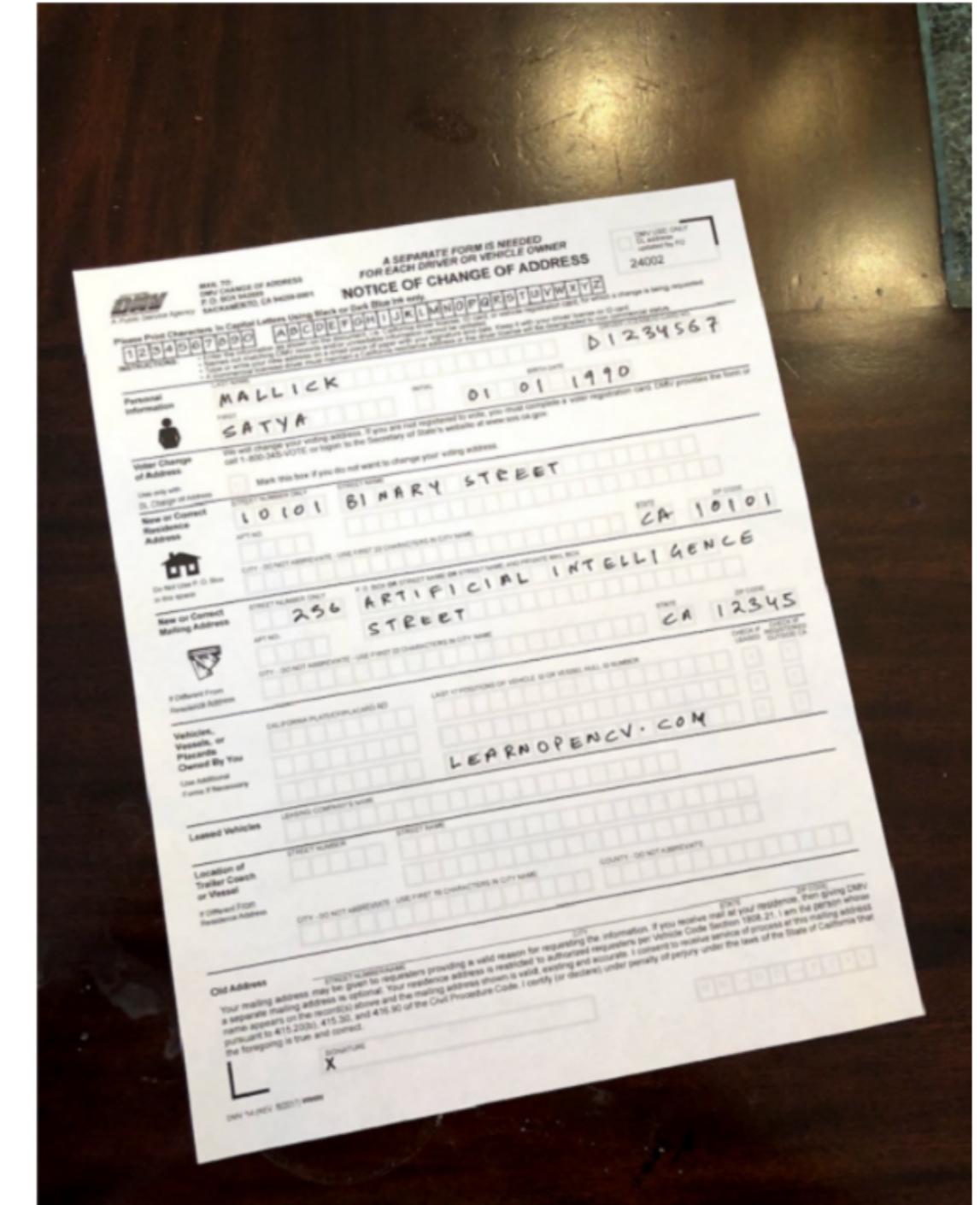
Old Address
STREET NUMBER/NAME: CITY: STATE: ZIP CODE:
Your mailing address may be given to requesters providing a valid reason for requesting the information. If you receive mail at your residence, then giving DMV a separate mailing address is optional. Your residence address is restricted to authorized requesters per Vehicle Code Section 1808.21. I am the person whose name appears on the record(s) above and the mailing address shown is valid, existing and accurate. I consent to receive service of process at this mailing address pursuant to 415.20(b), 415.30, and 416.90 of the Civil Procedure Code. I certify (or declare) under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

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Scanned Form



Find Key Point in Both Images

```
In [15]: #Convert Image to GrayScale
OriginalFormImage_gray = cv2.cvtColor(OriginalFormImage, cv2.COLOR_BGR2GRAY)
ScannedFormImage_gray = cv2.cvtColor(ScannedFormImage, cv2.COLOR_BGR2GRAY)

#Detect ORB Features and Compute Descriptors
#Oriented FAST and Rotated BRIEF. it is a good alternative to SIFT and SURF in computation cost
MAX_NUM_FEATURES = 500
orb = cv2.ORB_create(MAX_NUM_FEATURES)

#keyPoints are Edge, Corner
#descriptors are pixel of Corners, describe the Location, Size, Scale and Orientation of the keyPoints.
#descriptors are vector representation of the pixel Information of the keyPoints that matches both images
keypoints1, descriptors1 = orb.detectAndCompute(OriginalFormImage_gray, None)
keypoints2, descriptors2 = orb.detectAndCompute(ScannedFormImage_gray, None)

#View
OriginalForm_display = cv2.drawKeypoints(OriginalFormImage,
                                         keypoints1,
                                         outImage = np.array([]),
                                         color = (255, 0, 0),
                                         flags = cv2.DRAW_MATCHES_FLAGS_DRAW_RICH_KEYPOINTS)

ScannedForm_display = cv2.drawKeypoints(ScannedFormImage,
                                         keypoints2,
                                         outImage = np.array([]),
                                         color = (255, 0, 0),
                                         flags = cv2.DRAW_MATCHES_FLAGS_DRAW_RICH_KEYPOINTS)
```

In [16]: #Plotting Images

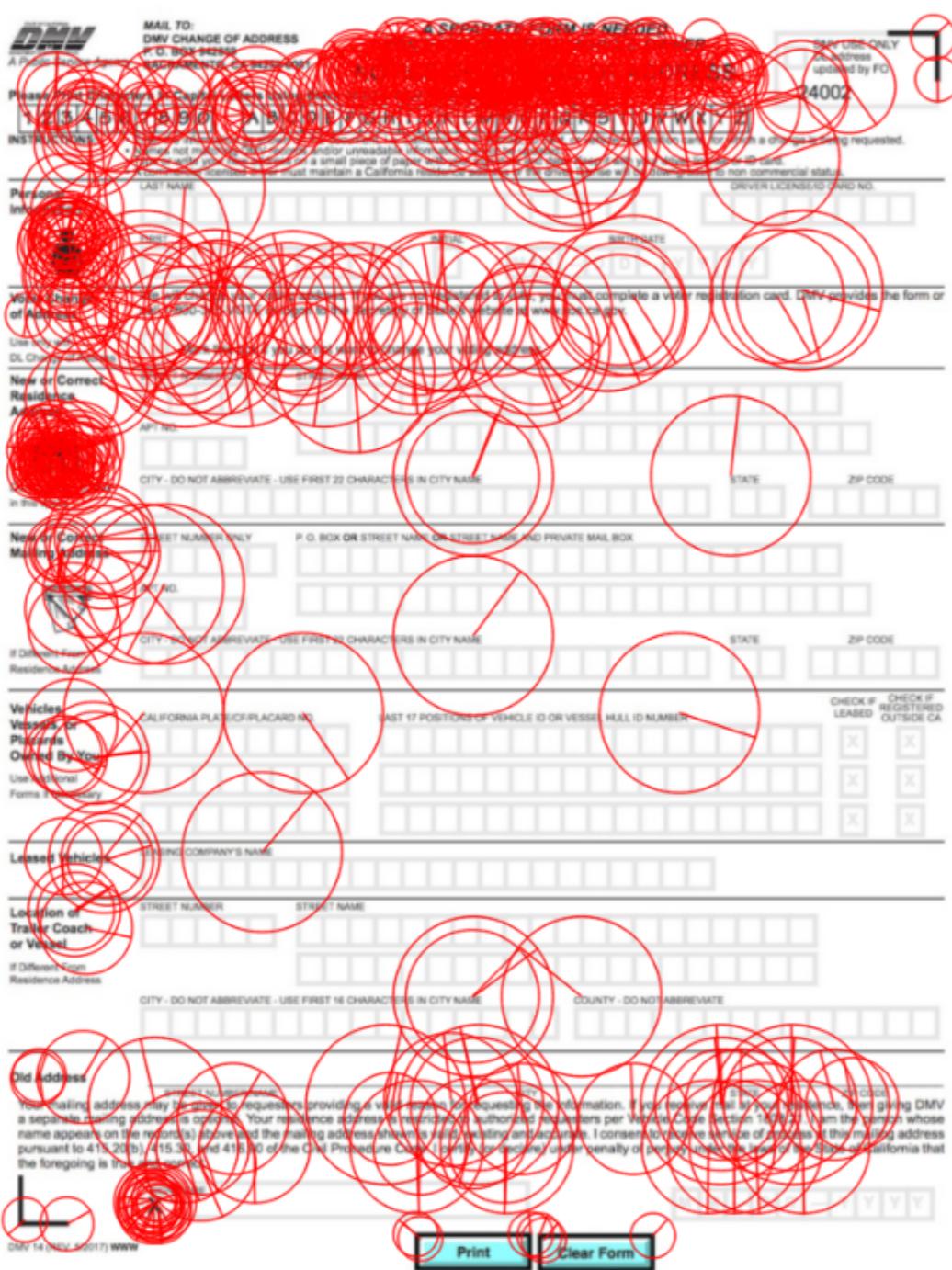
```
plt.figure(figsize = (20, 10))

plt.subplot(121)
plt.imshow(OriginalForm_display)
plt.axis("off")
plt.title("Original Form", color = "blue")

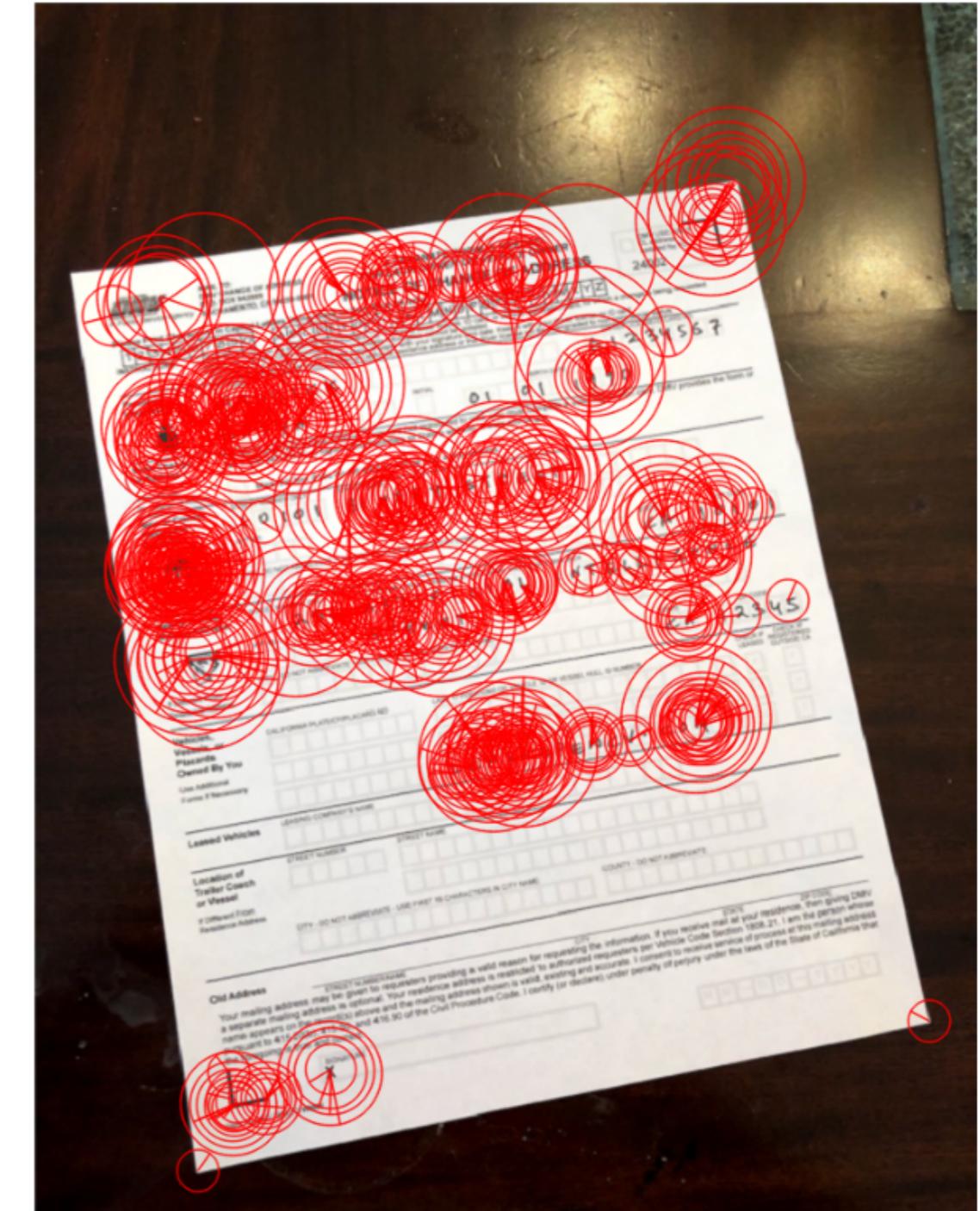
plt.subplot(122)
plt.imshow(ScannedForm_display)
plt.axis("off")
plt.title("Scanned Form", color = "blue")
```

Out[16]: Text(0.5, 1.0, 'Scanned Form')

Original Form



Scanned Form



```
In [17]: #We've calculated the keypoints and descriptors of both images Where all the -->
#Red circles represents keypoints
#The center of the circle represents the location of the keypoints
#The size of the circle represents the scale of the keypoints
#The line connected from the center of the circle to outside of the circle represents the orientation of the keypoints
```

Match Keypoints in the Two Images

```
In [18]: #Match Features
matcher = cv2.DescriptorMatcher_create(cv2.DESCRIPTOR_MATCHER_BRUTEFORCE_HAMMING)
#Converting to List for Sorting as Tuples are Immutable Objects
matches = list(matcher.match(descriptors1, descriptors2, None))

#Sort Matches by Score
matches.sort(key = lambda x: x.distance, reverse = False)

#Remove not so Good Matches
numGoodMatches = int(len(matches) * 0.1)
matches = matches[:numGoodMatches]
```

In [19]: #Draw Top Matches

```
img_matches = cv2.drawMatches(OriginalFormImage, keypoints1, ScannedFormImage, keypoints2, matches, None)

#view
plt.figure(figsize = (40, 10))
plt.imshow(img_matches)
plt.axis("off")
plt.title("Original Form")
```

Out[19]: Text(0.5, 1.0, 'Original Form')

Original Form

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Vehicles, Vessels, or Placards Owned By You: CALIFORNIA PLATE/CFL/PLACARD NO. LEASING COMPANY'S NAME

Use Additional Forms If Necessary: STREET NUMBER STREET NAME

Leased Vehicle: LEASING COMPANY'S NAME

Location of Trailer Coach or Vessel: STREET NUMBER STREET NAME COUNTY - DO NOT ABBREVIATE

CITY - DO NOT ABBREVIATE - USE FIRST 16 CHARACTERS IN CITY NAME COUNTY - DO NOT ABBREVIATE

Old Address: STREET NUMBER/NAME CITY STATE ZIP CODE

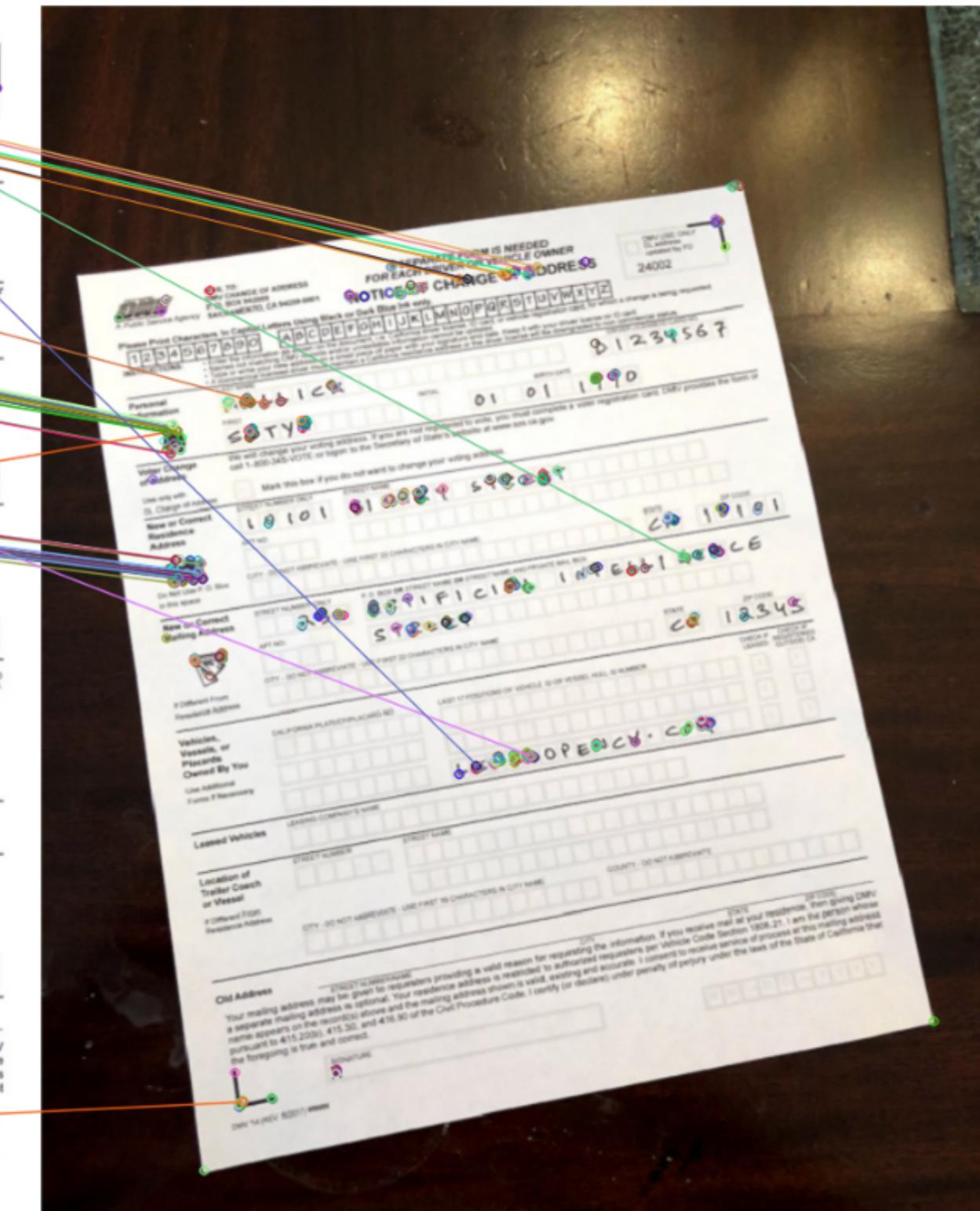
Your mailing address may be given to requesters providing a valid reason for requesting the information. If you receive your residence address giving DMV a separate mailing address is optional. Your residence address is restricted to authorized requesters per Vehicle Code Section 1308.21. I am the person whose name appears on the record(s) above and the mailing address shown is valid, listing and accurate. I consent to receive service of process at this mailing address pursuant to 415.20(b), 415.30, and 416.30 of the Civil Procedure Code. I certify (or declare) under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

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Find Homography

```
In [20]: #Extract Location of Good Matches
points1 = np.zeros((len(matches), 2), dtype = np.float32)
points2 = np.zeros((len(matches), 2), dtype = np.float32)

for i, match in enumerate(matches):
    points1[i, :] = keypoints1[match.queryIdx].pt
    points2[i, :] = keypoints2[match.trainIdx].pt

#Find HomoGraphy
h, mask = cv2.findHomography(points2, points1, cv2.RANSAC)
```

Wrap Image

```
In [21]: height, width, channels = OriginalFormImage.shape
ScannedFormImage_reg = cv2.warpPerspective(ScannedFormImage, h, (width, height))

#Display Results
plt.figure(figsize = (20, 10))

plt.subplot(121)
plt.imshow(OriginalFormImage)
plt.axis("off")
plt.title("Original Form")

plt.subplot(122)
plt.imshow(ScannedFormImage_reg)
plt.axis("off")
plt.title("Scanned Form")
```

Out[21]: Text(0.5, 1.0, 'Scanned Form')

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 CHECK IF LEASED CHECK IF REGISTERED OUTSIDE CA

Use Additional Forms If Necessary

Leased Vehicles LEASING COMPANY'S NAME:

Location of Trailer Coach or Vessel
 STREET NUMBER: STREET NAME:
 If Different From Residence Address
 CITY - DO NOT ABBREVIATE - USE FIRST 16 CHARACTERS IN CITY NAME: COUNTY - DO NOT ABBREVIATE:

Old Address
 STREET NUMBER/NAME: CITY: STATE: ZIP CODE:
 Your mailing address may be given to requesters providing a valid reason for requesting the information. If you receive mail at your residence, then giving DMV a separate mailing address is optional. Your residence address is restricted to authorized requesters per Vehicle Code Section 1808.21. I am the person whose name appears on the record(s) above and the mailing address shown is valid, existing and accurate. I consent to receive service of process at this mailing address pursuant to 415.20(b), 415.30, and 416.90 of the Civil Procedure Code. I certify (or declare) under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

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