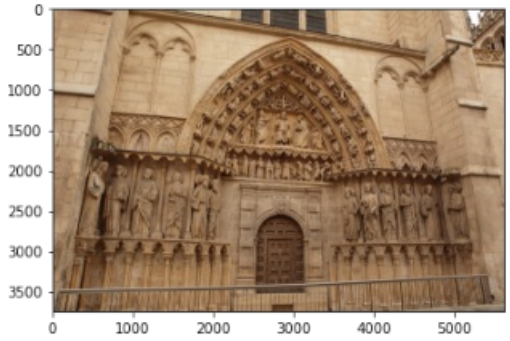
In [7]:

```
import numpy as np
import pandas as pd
from IPython.display import Image,display
from skimage import io
import matplotlib.pyplot as plt

image = io.imread('../input/stitching-images/one.png')
plt.imshow(image)
plt.axis('off')
plt.show()
```



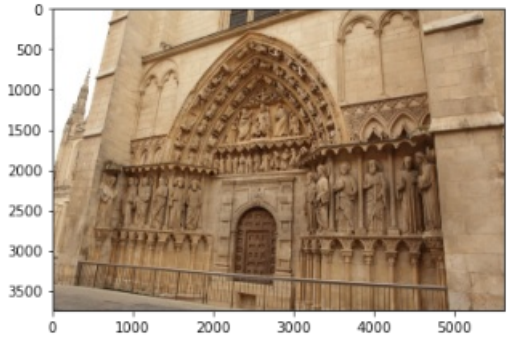
In [9]:

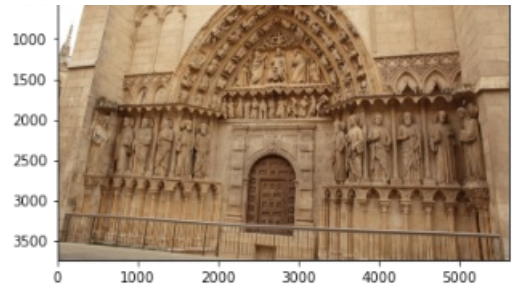
```
import os

list = os.listdir('../input/stitching-images')
for i in range(len(list)):
  print(list[i])
```

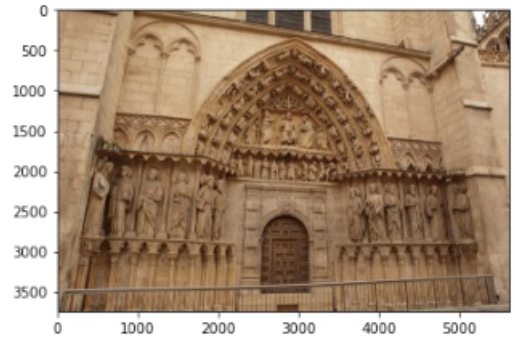
```
three.png
two.png
one.png
```

In [11]:

```
import matplotlib.image as mpimg

def process(filename):
    image = mpimg.imread('../input/stitching-images/'+filename)
    plt.figure()
    plt.imshow(image)
    plt.axis('off')

for file in list:
    process(file)
```

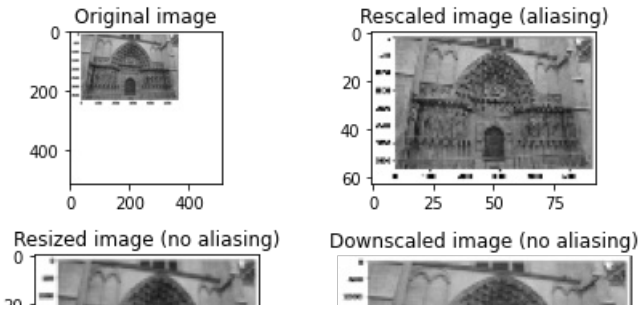


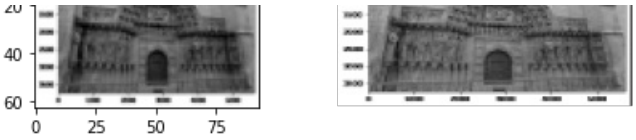




In [13]:

```
import matplotlib.pyplot as plt
import cv2
from skimage import data, color
from skimage.transform import rescale, resize, downscale_local_mean

img = cv2.imread('../input/stitching-images/one.png')
image = color.rgb2gray(img)

image_rescaled = rescale(image, 0.25, anti_aliasing=False)
image_resized = resize(image, (image.shape[0] // 4, image.shape[1] // 4),
                       anti_aliasing=True)
image_downscaled = downscale_local_mean(image, (4, 3))

fig, axes = plt.subplots(nrows=2, ncols=2)

ax = axes.ravel()

ax[0].imshow(image, cmap='gray')
ax[0].set_title("Original image")

ax[1].imshow(image_rescaled, cmap='gray')
ax[1].set_title("Rescaled image (aliasing)")

ax[2].imshow(image_resized, cmap='gray')
ax[2].set_title("Resized image (no aliasing)")

ax[3].imshow(image_downscaled, cmap='gray')
ax[3].set_title("Downscaled image (no aliasing)")

ax[0].set_xlim(0, 512)
ax[0].set_ylim(512, 0)
plt.tight_layout()
plt.axis('off')
plt.show()
```





In [16]:

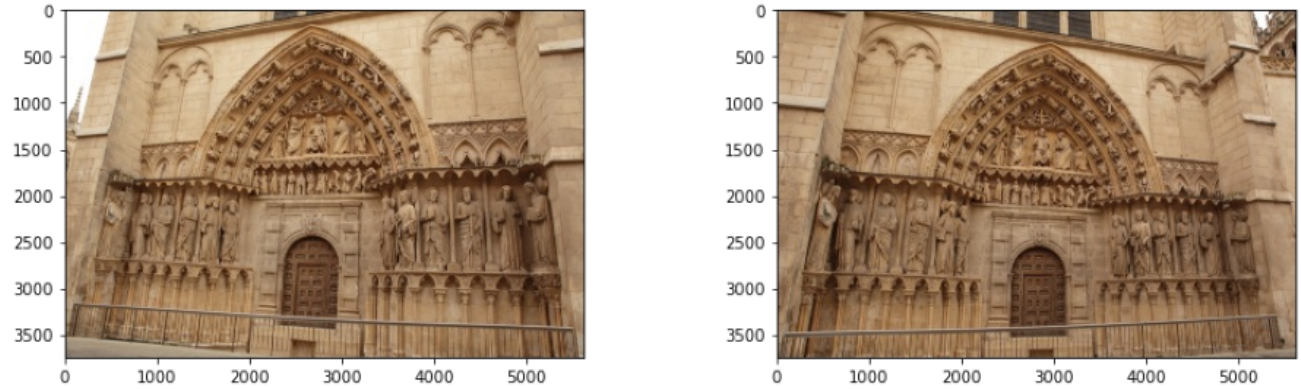
```
import cv2
import numpy as np
import matplotlib.pyplot as plt
import imageio
import imutils
cv2.ocl.setUseOpenCL(False)
```

In [17]:

```
feature_extractor = 'orb' # one of 'sift', 'surf', 'brisk', 'orb'
feature_matching = 'bf'
```

In [21]:

```
# Make sure that the train image is the image that will be transformed
trainImg = imageio.imread('../input/stitching-images/one.png')
trainImg_gray = cv2.cvtColor(trainImg, cv2.COLOR_RGB2GRAY)

queryImg = imageio.imread('../input/stitching-images/two.png')
# Opencv defines the color channel in the order BGR.
# Transform it to RGB to be compatible to matplotlib
queryImg_gray = cv2.cvtColor(queryImg, cv2.COLOR_RGB2GRAY)

fig, (ax1, ax2) = plt.subplots(nrows=1, ncols=2, constrained_layout=False, figsize=(16,9))
ax1.imshow(queryImg, cmap="gray")
ax1.set_xlabel("Query image", fontsize=14)
ax1.set_axis_off()

ax2.imshow(trainImg, cmap="gray")
ax2.set_xlabel("Train image (Image to be transformed)", fontsize=14)
ax2.set_axis_off()

plt.show()
```



In [22]:

```
def detectAndDescribe(image, method=None):
    """
    Compute key points and feature descriptors using an specific method
    """

    assert method is not None, "You need to define a feature detection method. Values are: 'sift',
'surf'"

    # detect and extract features from the image
    if method == 'sift':
        descriptor = cv2.xfeatures2d.SIFT_create()
    elif method == 'surf':
```

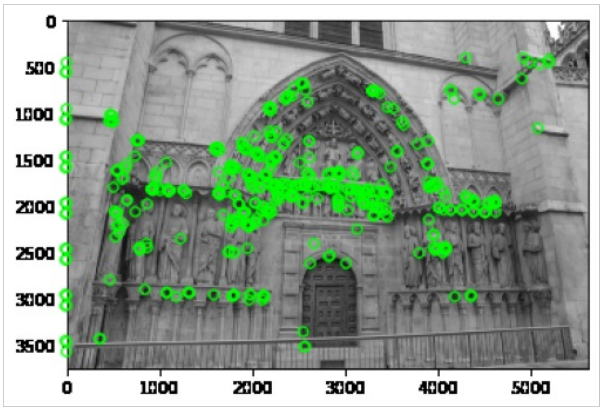
```
        descriptor = cv2.xfeatures2d.SURF_create()
    elif method == 'brisk':
        descriptor = cv2.BRISK_create()
    elif method == 'orb':
        descriptor = cv2.ORB_create()

    # get keypoints and descriptors
    (kps, features) = descriptor.detectAndCompute(image, None)

    return (kps, features)
```

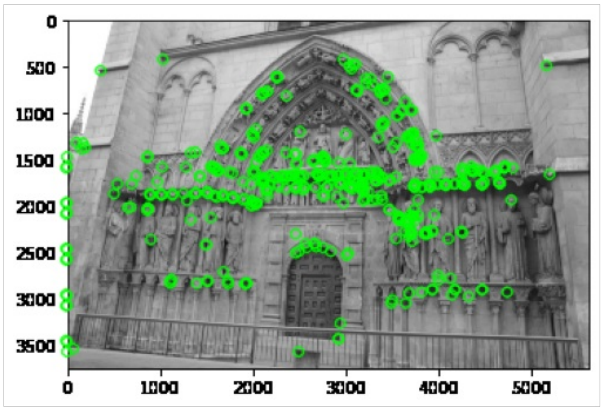
In [23]:

```
kpsA, featuresA = detectAndDescribe(trainImg_gray, method=feature_extractor)
kpsB, featuresB = detectAndDescribe(queryImg_gray, method=feature_extractor)
```

In [25]:

```
# display the keypoints and features detected on both images
fig, (ax1,ax2) = plt.subplots(nrows=1, ncols=2, figsize=(20,8), constrained_layout=False)
ax1.imshow(cv2.drawKeypoints(trainImg_gray,kpsA,None,color=(0,255,0)))
ax1.set_xlabel("", fontsize=14)
ax1.set_axis_off()
ax2.imshow(cv2.drawKeypoints(queryImg_gray,kpsB,None,color=(0,255,0)))
ax2.set_xlabel("(b)", fontsize=14)
ax2.set_axis_off()
plt.show()
```





In [26]:

```
def createMatcher(method,crossCheck):
    "Create and return a Matcher Object"

    if method == 'sift' or method == 'surf':
        bf = cv2.BFMatcher(cv2.NORM_L2, crossCheck=crossCheck)
    elif method == 'orb' or method == 'brisk':
        bf = cv2.BFMatcher(cv2.NORM_HAMMING, crossCheck=crossCheck)
    return bf
```

In [27]:

```
def matchKeyPointsBF(featuresA, featuresB, method):
    bf = createMatcher(method, crossCheck=True)

    # Match descriptors.
    best_matches = bf.match(featuresA,featuresB)

    # Sort the features in order of distance.
    # The points with small distance (more similarity) are ordered first in the vector
    rawMatches = sorted(best_matches, key = lambda x:x.distance)
    print("Raw matches (Brute force):", len(rawMatches))
    return rawMatches
```

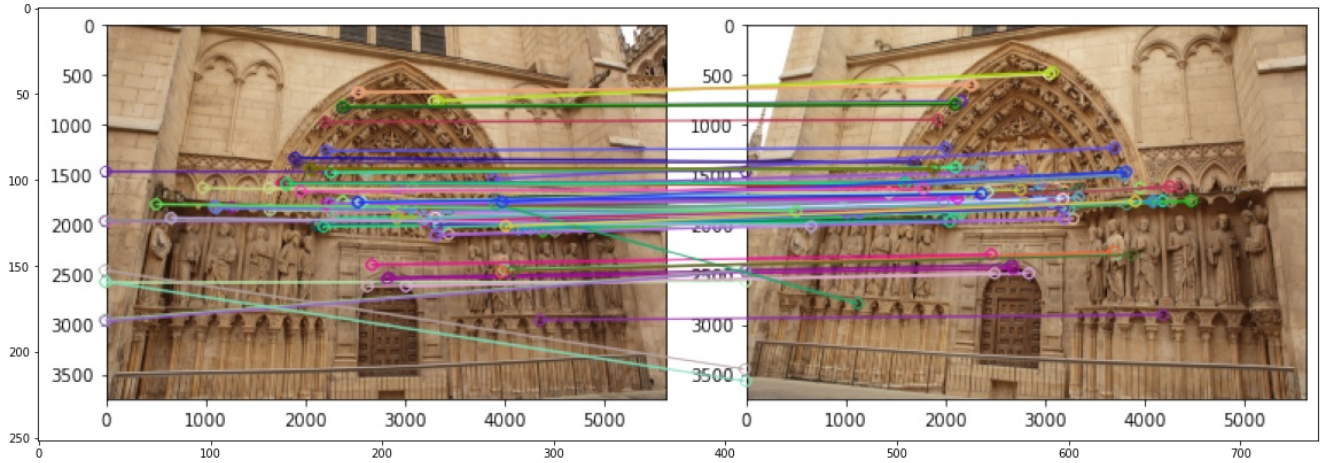
In [28]:

```
def matchKeyPointsKNN(featuresA, featuresB, ratio, method):
    bf = createMatcher(method, crossCheck=False)
    # compute the raw matches and initialize the list of actual matches
    rawMatches = bf.knnMatch(featuresA, featuresB, 2)
    print("Raw matches (knn):", len(rawMatches))
    matches = []

    # loop over the raw matches
    for m,n in rawMatches:
        # ensure the distance is within a certain ratio of each
        # other (i.e. Lowe's ratio test)
        if m.distance < n.distance * ratio:
            matches.append(m)
    return matches
```

In [29]:

```
print("Using: {} feature matcher".format(feature_matching))

fig = plt.figure(figsize=(20,8))

if feature_matching == 'bf':
    matches = matchKeyPointsBF(featuresA, featuresB, method=feature_extractor)
    img3 = cv2.drawMatches(trainImg,kpsA,queryImg,kpsB,matches[:100],
                           None,flags=cv2.DrawMatchesFlags_NOT_DRAW_SINGLE_POINTS)
elif feature_matching == 'knn':
    matches = matchKeyPointsKNN(featuresA, featuresB, ratio=0.75, method=feature_extractor)
    img3 = cv2.drawMatches(trainImg,kpsA,queryImg,kpsB,np.random.choice(matches,100),
                           None,flags=cv2.DrawMatchesFlags_NOT_DRAW_SINGLE_POINTS)


plt.imshow(img3)
plt.show()
```

```
Using: bf feature matcher
Raw matches (Brute force): 206
```



In [30]:

```
def getHomography(kpsA, kpsB, featuresA, featuresB, matches, reprojThresh):
    # convert the keypoints to numpy arrays
    kpsA = np.float32([kp.pt for kp in kpsA])
    kpsB = np.float32([kp.pt for kp in kpsB])

    if len(matches) > 4:

        # construct the two sets of points
        ptsA = np.float32([kpsA[m.queryIdx] for m in matches])
        ptsB = np.float32([kpsB[m.trainIdx] for m in matches])

        # estimate the homography between the sets of points
        (H, status) = cv2.findHomography(ptsA, ptsB, cv2.RANSAC,
            reprojThresh)

        return (matches, H, status)
    else:
```

```
    else:
        return None
```

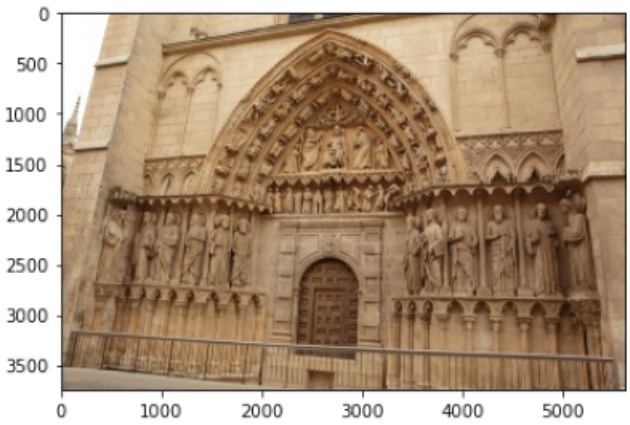
In [31]:

```
M = getHomography(kpsA, kpsB, featuresA, featuresB, matches, reprojThresh=4)
if M is None:
    print("Error!")
(matches, H, status) = M
print(H)
```

```
[[ 1.07294457e+00  2.32709393e-01 -3.67265997e+01]
 [-1.21842714e-01  1.06220661e+00  1.74162740e+01]
 [-2.21212383e-05  6.01767672e-04  1.00000000e+00]]
```

In [34]:

```
# Apply panorama correction
width = trainImg.shape[1] + queryImg.shape[1]
height = trainImg.shape[0] + queryImg.shape[0]

result = cv2.warpPerspective(trainImg, H, (width, height))
result[0:queryImg.shape[0], 0:queryImg.shape[1]] = queryImg

plt.figure(figsize=(20,10))
plt.imshow(result)

plt.axis('off')
plt.show()
```



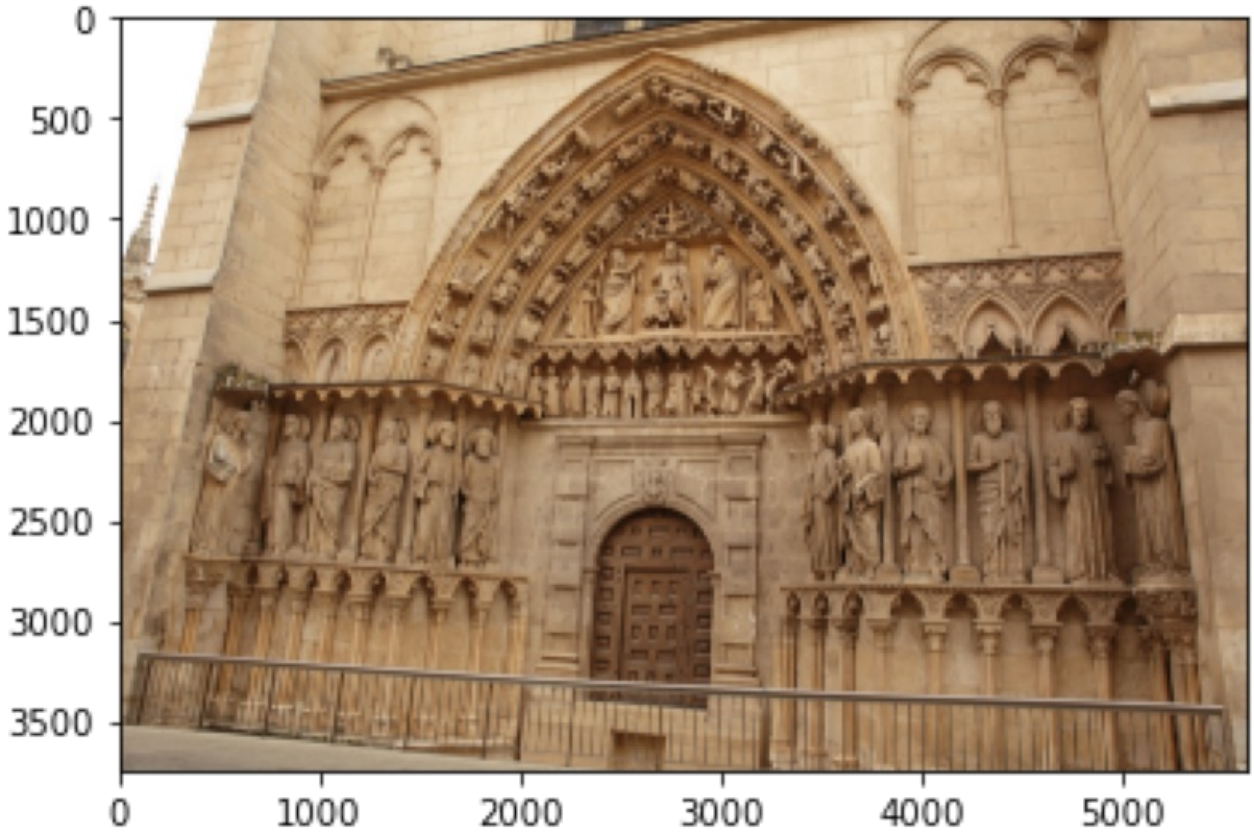
In [35]:

```
# transform the panorama image to grayscale and threshold it
gray = cv2.cvtColor(result, cv2.COLOR_BGR2GRAY)
thresh = cv2.threshold(gray, 0, 255, cv2.THRESH_BINARY)[1]

# Finds contours from the binary image
cnts = cv2.findContours(thresh.copy(), cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)
cnts = imutils.grab_contours(cnts)
```

```
# get the maximum contour area
c = max(cnts, key=cv2.contourArea)

# get a bbox from the contour area
(x, y, w, h) = cv2.boundingRect(c)

# crop the image to the bbox coordinates
result = result[y:y + h, x:x + w]

# show the cropped image
plt.figure(figsize=(20,10))
plt.axis('off')
plt.imshow(result)
```

Out[35]:

```
<matplotlib.image.AxesImage at 0x7f3d4492d7d0>
```



In [ ]: