DEVNAGRI CHARACTER DATASET

In [7]:

```
import tensorflow as tf
from tensorflow import keras
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import joblib
import cv2
import numpy as np
from operator import itemgetter
from sklearn.model_selection import train_test_split
```

In [8]:

```
url='data.csv'
df=pd.read_csv(url)
df
```

Out[8]:

	pixel_0000	pixel_0001	pixel_0002	pixel_0003	pixel_0004	pixel_0005	pixel_0006	pixel_
0	0	0	0	0	0	0	0	
1	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	
4	0	0	0	0	0	0	0	
...	...	...	...	...	...	...	...	
91995	0	0	0	0	0	0	0	
91996	0	0	0	0	0	0	0	
91997	0	0	0	0	0	0	0	
91998	0	0	0	0	0	0	0	
91999	0	0	0	0	0	0	0	

92000 rows × 1025 columns

In [9]:

```
X= df.iloc[:, 0:-1]
y = df.iloc[:, -1]
mapping_to_numbers = {}
y1 = np.zeros((len(y)))
for i, raw_label in enumerate(y):
    if raw_label not in mapping_to_numbers:
        mapping_to_numbers[raw_label] = len(mapping_to_numbers)
    y1[i] = mapping_to_numbers[raw_label]
X_train, X_test, y_train, y_test = train_test_split(X, y1, test_size=0.33)
y_train

mapping_to_numbers
```

Out[9]:

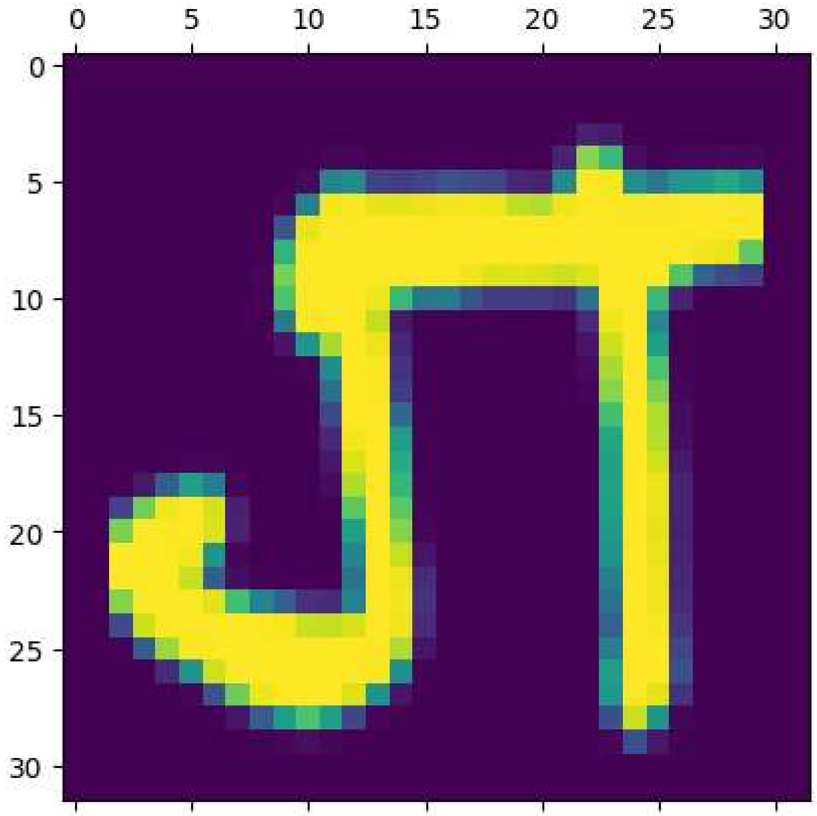
```
{'character_01_ka': 0,
 'character_02_kha': 1,
 'character_03_ga': 2,
 'character_04_gha': 3,
 'character_05_kna': 4,
 'character_06_cha': 5,
 'character_07_chha': 6,
 'character_08_ja': 7,
 'character_09_jha': 8,
 'character_10_yna': 9,
 'character_11_taamatar': 10,
 'character_12_thaa': 11,
 'character_13_daa': 12,
 'character_14_dhaa': 13,
 'character_15_adna': 14,
 'character_16_tabala': 15,
 'character_17_tha': 16,
 'character_18_da': 17,
 'character_19_dha': 18,
 'character_20_na': 19,
 'character_21_pa': 20,
 'character_22_pha': 21,
 'character_23_ba': 22,
 'character_24_bha': 23,
 'character_25_ma': 24,
 'character_26_yaw': 25,
 'character_27_ra': 26,
 'character_28_la': 27,
 'character_29_waw': 28,
 'character_30_motosaw': 29,
 'character_31_petchiryakha': 30,
 'character_32_patalosaw': 31,
 'character_33_ha': 32,
 'character_34_chhya': 33,
 'character_35_tra': 34,
 'character_36_gya': 35,
 'digit_0': 36,
 'digit_1': 37,
 'digit_2': 38,
 'digit_3': 39,
 'digit_4': 40,
 'digit_5': 41,
 'digit_6': 42,
 'digit_7': 43,
 'digit_8': 44,
 'digit_9': 45}
```

In [13]:

```
X_train=X_train.reshape((61640,32,32))
X_test=X_test.reshape((30360,32,32))
```

```
In [14]: plt.matshow(X_train[15])
```

```
Out[14]: <matplotlib.image.AxesImage at 0x23139a17d30>
```



```
In [15]: 
         y_train[15]
```

```
Out[15]: 2.0
```

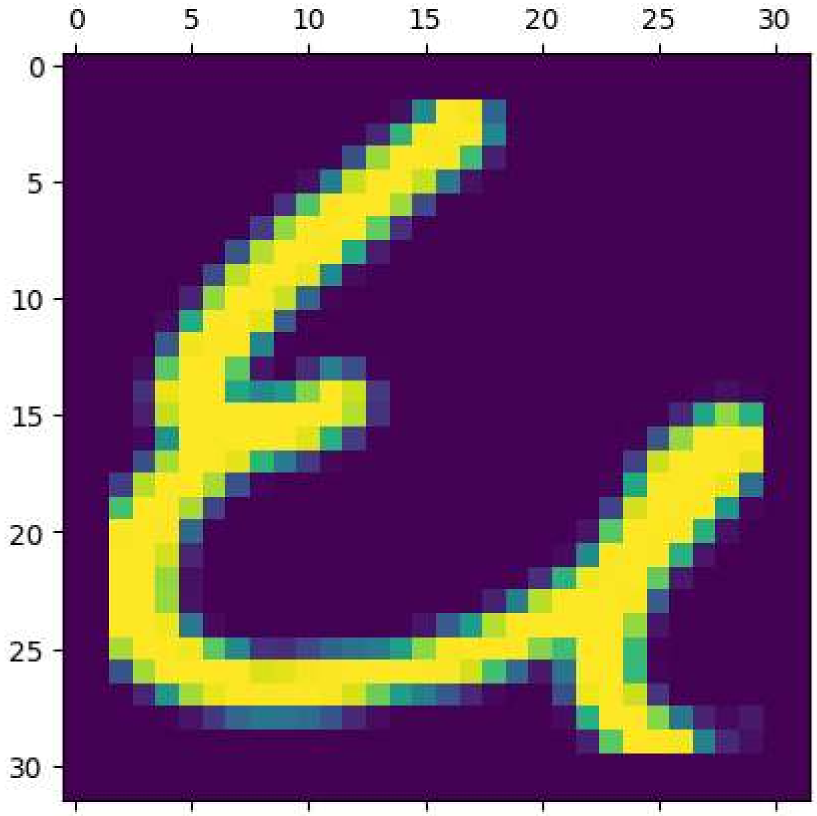
```
In [16]: y_train
```

```
Out[16]: array([25., 45., 44., ..., 30., 40., 13.])
```

```
In [17]: Xtrain=X_train/255
         Xtest=X_test/255
```

```
In [18]: plt.matshow(Xtrain[39])
```

```
Out[18]: <matplotlib.image.AxesImage at 0x231398ece50>
```



MODEL PREPARATION STARTS :

ADDING A HIDDEN LAYER IN BETWEEN

In [ ]:

```
from keras import models
from keras import layers
model = models.Sequential()
model.add(layers.Conv2D(32, kernel_size=(3, 3),activation='relu',input_shape=
model.add(layers.Conv2D(64, (3, 3), activation='relu'))
model.add(layers.MaxPooling2D(pool_size=(2, 2)))
model.add(layers.Dropout(0.25))
model.add(layers.Flatten())
model.add(layers.Dense(128, activation='relu'))
model.add(layers.Dropout(0.5))
model.add(layers.Dense(46, activation='softmax'))
model.compile(
    optimizer='adam',
    loss='sparse_categorical_crossentropy',
    metrics=['accuracy']
)
model.fit(Xtrain,y_train,epochs=4,validation_data=(Xtest,y_test))
```

```
Epoch 1/4
1927/1927 [==============================] - 134s 69ms/step - loss: 1.0597 -
accuracy: 0.6957 - val_loss: 0.2629 - val_accuracy: 0.9266
Epoch 2/4
1927/1927 [==============================] - 139s 72ms/step - loss: 0.4677 -
accuracy: 0.8554 - val_loss: 0.1702 - val_accuracy: 0.9515
Epoch 3/4
1927/1927 [==============================] - 139s 72ms/step - loss: 0.3535 -
accuracy: 0.8899 - val_loss: 0.1334 - val_accuracy: 0.9600
Epoch 4/4
1681/1927 [=========================>....] - ETA: 15s - loss: 0.2848 - accur
acy: 0.9099
```

In [29]:

```
model.evaluate(Xtest,y_test)
```

```
949/949 [==============================] - 16s 17ms/step - loss: 0.1335 - ac
curacy: 0.9618
```

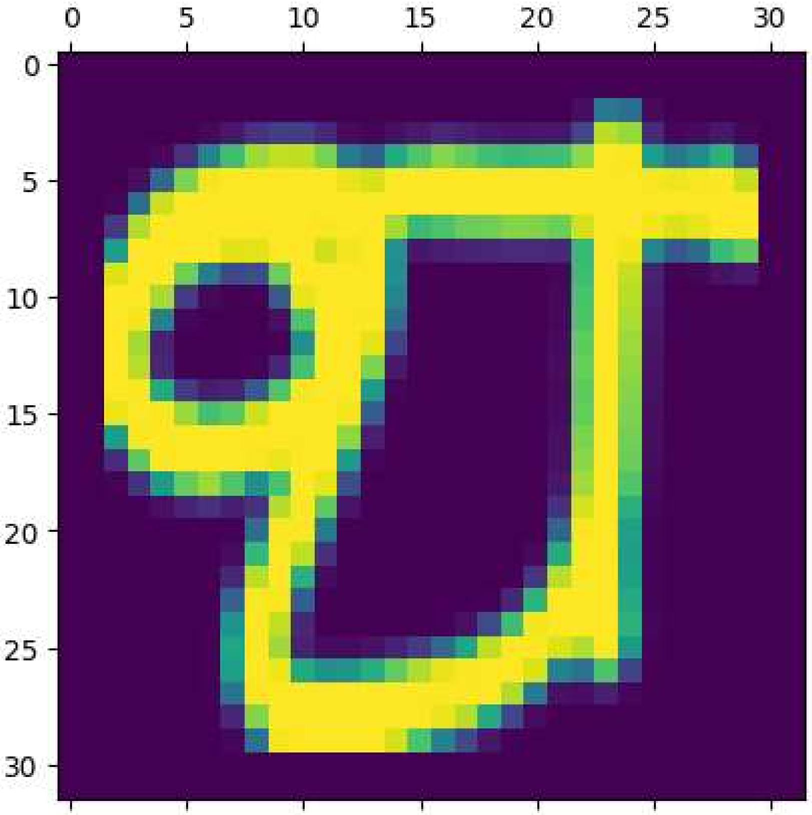
Out[29]:

```
[0.13352523744106293, 0.9617918133735657]
```

In [41]:
```
y_pred=model.predict(Xtest)
y_pred_label=[np.argmax(i) for i in y_pred]
plt.matshow(Xtest[1])
```

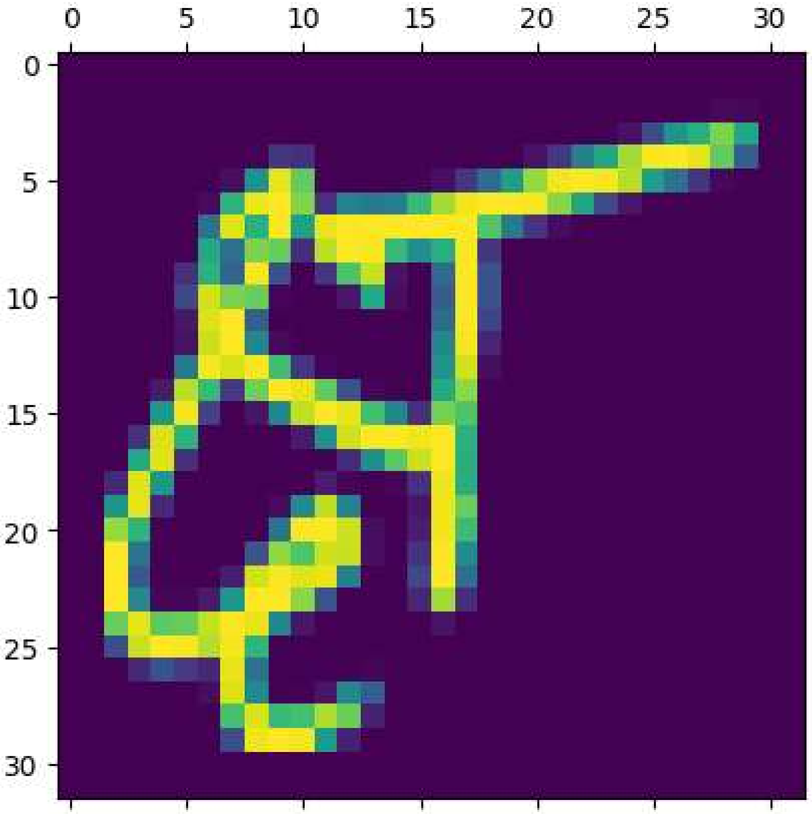
```
949/949 [==============================] - 12s 13ms/step
```

Out[41]:
```
<matplotlib.image.AxesImage at 0x1d613e8d690>
```

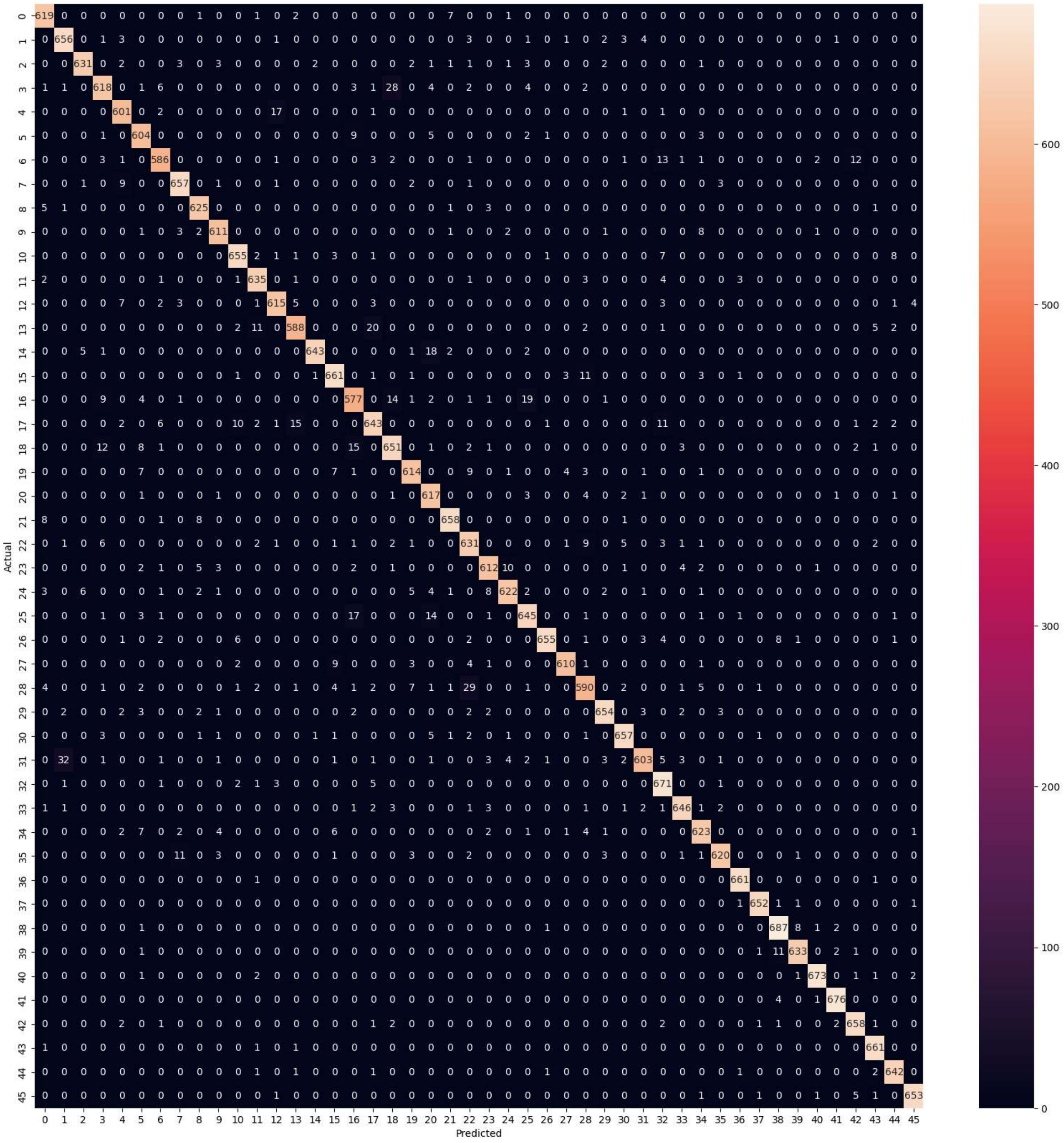


```
In [42]: plt.matshow(Xtest[3])
         print(y_pred[3])
         print(y_pred_label[3])
```

```
[1.24977871e-12 4.59704580e-10 9.99207462e-18 2.12872715e-06
 1.94011163e-09 6.33143223e-13 2.14517016e-07 6.77456612e-15
 1.33189649e-11 1.28596989e-13 6.54588078e-14 1.79835069e-15
 4.54280117e-15 1.01468460e-11 9.65802891e-15 3.81296015e-14
 1.71804945e-10 8.01499755e-10 2.09385644e-06 7.14796555e-10
 5.54510013e-16 4.01459180e-16 2.11028464e-06 9.15484147e-11
 9.57812321e-14 1.70180493e-13 1.27119154e-13 2.58701505e-10
 9.38127839e-11 1.80864923e-08 4.57475002e-10 2.90129272e-08
 2.45242700e-06 9.99990225e-01 1.37046180e-10 7.27899703e-07
 2.69162216e-16 7.90670779e-17 1.10758211e-13 4.88434651e-13
 1.17168506e-08 1.59503539e-11 1.95895278e-09 1.18534934e-12
 1.23535605e-14 2.71091882e-11]
33
```



In [31]:
```
import seaborn as sns
plt.figure(figsize=(20,20))
cm=tf.math.confusion_matrix(labels=y_test,predictions=y_pred_label)
sns.heatmap(cm,annot=True,fmt='d')
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.show()
```



In [43]:

```
joblib.dump(model, 'final_model1.pkl')
```

```
Keras weights file (<HDF5 file "variables.h5" (mode r+)>) saving:
...layers\conv2d
......vars
.........0
.........1
...layers\conv2d_1
......vars
.........0
.........1
...layers\dense
......vars
.........0
.........1
...layers\dense_1
......vars
.........0
.........1
...layers\dropout
......vars
...layers\dropout_1
......vars
...layers\flatten
......vars
...layers\max_pooling2d
......vars
...metrics\mean
......vars
.........0
.........1
...metrics\mean_metric_wrapper
......vars
.........0
.........1
...optimizer
......vars
.........0
.........1
.........10
.........11
.........12
.........13
.........14
.........15
.........16
.........2
.........3
.........4
.........5
.........6
.........7
.........8
.........9
...vars
Keras model archive saving:
File Name                                             Modified             S
ize
config.json                                    2022-12-05 23:34:28         3
```

```
190
metadata.json                                  2022-12-05 23:34:28
64
variables.h5                                   2022-12-05 23:34:28     19600
512
```

```
Out[43]: ['final_model1.pkl']
```

HANDRAWN IMAGE PREPROCESSING

In [44]:

```
def convert(output):
    if(output==0):
        print("क")
    elif output==1:
        print("ख")
    elif output==2:
        print("ग")
    elif output==3:
        print("घ")
    elif output==4:
        print("ङ")
    elif output==5:
         print("च")
    elif output==6:
        print("छ")
    elif output==7:
        print("ज")
    elif output==8:
        print("झ")
    elif output==9:
        print("ञ")
    elif output==10:
        print("ट")
    elif output==11:
        print("ठ")
    elif output==12:
        print("ड")
    elif output==13:
        print("ढ")
    elif output==14:
        print("ण")
    elif output==15:
        print("त")
    elif output==16:
        print("थ")
    elif output==17:
        print("द")
    elif output==18:
        print("ध")
    elif output==19:
        print("न")
    elif output==20:
        print("प")
    elif output==21:
        print("फ")
    elif output==22:
        print("ब")
    elif output==23:
        print("भ")
    elif output==24:
        print("म")
    elif output==25:
        print("य")
    elif output==26:
        print("र")
    elif output==27:
        print("ल")
```

```python
    elif output==28:
        print("व")
    elif output==29:
        print("श")
    elif output==30:
        print("ष")
    elif output==31:
        print("स")
    elif output==32:
        print("ह")
    elif output==33:
        print("क्ष")
    elif output==34:
        print("त्र")
    elif output==35:
        print("ज्ञ")
    elif output==36:
        print("०")
    elif output==37:
        print("१")
    elif output==38:
        print("२")
    elif output==39:
        print("३")
    elif output==40:
        print("४")
    elif output==41:
        print("५")
    elif output==42:
        print("६")
    elif output==43:
        print("७")
    elif output==44:
        print("८")
    elif output==45:
        print("९")

    return output
```

```
In [37]: def get_sample_image(filename='hindi2.jpeg'):
             return cv2.imread(filename, 0) #grayscale image

         def binarize(img=get_sample_image()):
             thresh = cv2.adaptiveThreshold(img, 255,
                                            cv2.ADAPTIVE_THRESH_GAUSSIAN_C,
                                            cv2.THRESH_BINARY, 21,4)
             return thresh


         def find_digits(binary_img):
             inv = cv2.bitwise_not(binary_img)
             contours, hierarchy = cv2.findContours(inv,
                                                    cv2.RETR_EXTERNAL, cv2.CHAIN_APPRO
             digits = []
             for cnt in contours:
                 area = cv2.contourArea(cnt)
                 if area > 500:
                     [x, y, w, h] = cv2.boundingRect(cnt)
                     margin = 20
                     x -= margin
                     y -= margin
                     w += margin*2
                     h += margin*2

                     figure = binary_img[y: y + h, x: x + w]
                     if figure.size > 0:
                         digits.append({
                             'image': figure,
                             'x': x,
                             'y': y,
                             'w': w,
                             'h': h,
                         })

             return digits


         def resize_digits(digits):
             digits = map(itemgetter('image'), sorted(digits, key=itemgetter('x')))
             blur_kernel = np.ones((4, 4), np.float32)/(4*4)
             erode_kernel = cv2.getStructuringElement(cv2.MORPH_ELLIPSE, (5, 5))
             return [
                 cv2.resize(
                     cv2.bitwise_not(
                         cv2.filter2D(
                             cv2.erode(digit, erode_kernel, iterations=1),
                             -1, blur_kernel)
                     ),
                     (25, 25))
                 for digit in digits]


         def insert_into_center(resized_digits):
             results = []
             for img in resized_digits:
                 i = np.zeros((32, 32))
```

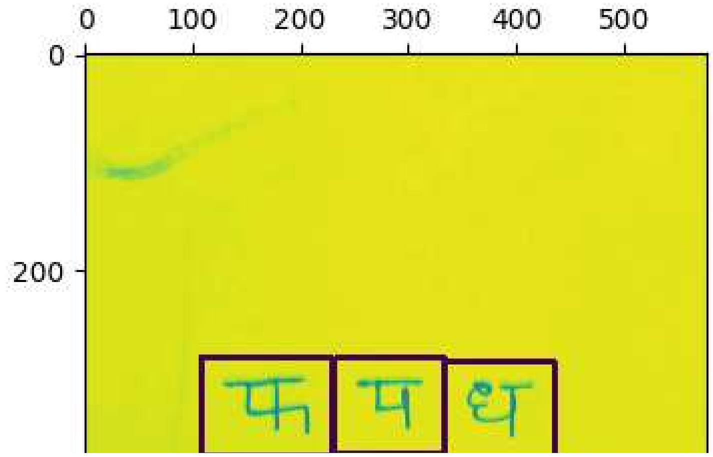
```
        M = cv2.moments(img)
        try:
            xc = M['m10'] / M['m00']
            yc = M['m01'] / M['m00']
        except ZeroDivisionError:
            xc = 10
            yc = 10

        start_a = max(min(4 + (10 - int(yc)), 8), 0)
        start_b = max(min(4 + (10 - int(xc)), 8), 0)
        i[start_a:start_a+25, start_b:start_b+25] = img

        results.append(i)
    return results
```

In [38]:

```
def draw_contours(frame, contours):
    for img in contours:
        im=cv2.rectangle(
            frame,
            (img['x'], img['y']),
            (img['x'] + img['w'], img['y'] + img['h']),
            (0, 0, 0),
            4
        )

def preprocess(digits):
    return np.vstack([digit.reshape((1,32,32,1)).astype(np.float64)/255
                      for digit in digits])

def static_image_ocr():
    frame = get_sample_image()
    contours = find_digits(binarize(frame.copy()))
    draw_contours(frame, contours)
    digits = insert_into_center(resize_digits(contours))
    X = preprocess(digits)
    y_pred_X = model.predict(X)
    y_pred_label_X = [np.argmax(i) for i in y_pred_X]
    plt.matshow(frame)
    plt.matshow(binarize(frame.copy()))
    for i,l1 in enumerate(X):
        plt.matshow(X[i])

    print("Total output:")

    result=[]
    for i in y_pred_label_X:
        result.append(convert(i))
```

```
In [39]: static_image_ocr()
```

```
1/1 [==============================] - 0s 42ms/step
Total output:
ख
प
ध
```



```
In [ ]:
```