In [78]:
```
import warnings
warnings.filterwarnings('ignore')
import keras
import matplotlib.pyplot as plt
import os
import cv2
import numpy as np
import pandas as pd
from keras.layers import Conv2D, Activation, MaxPool2D, Dense, Flatten, Dropout
```

In [79]:
```
# Define the categories and image size
CATEGORIES = ["01_palm", '02_l','03_fist','04_fist_moved','05_thumb','06_index','07_
IMG_SIZE = 50
```

In [80]:
```
# Define the data path
data_path = "/kaggle/input/leapgestrecog/leapGestRecog"
```

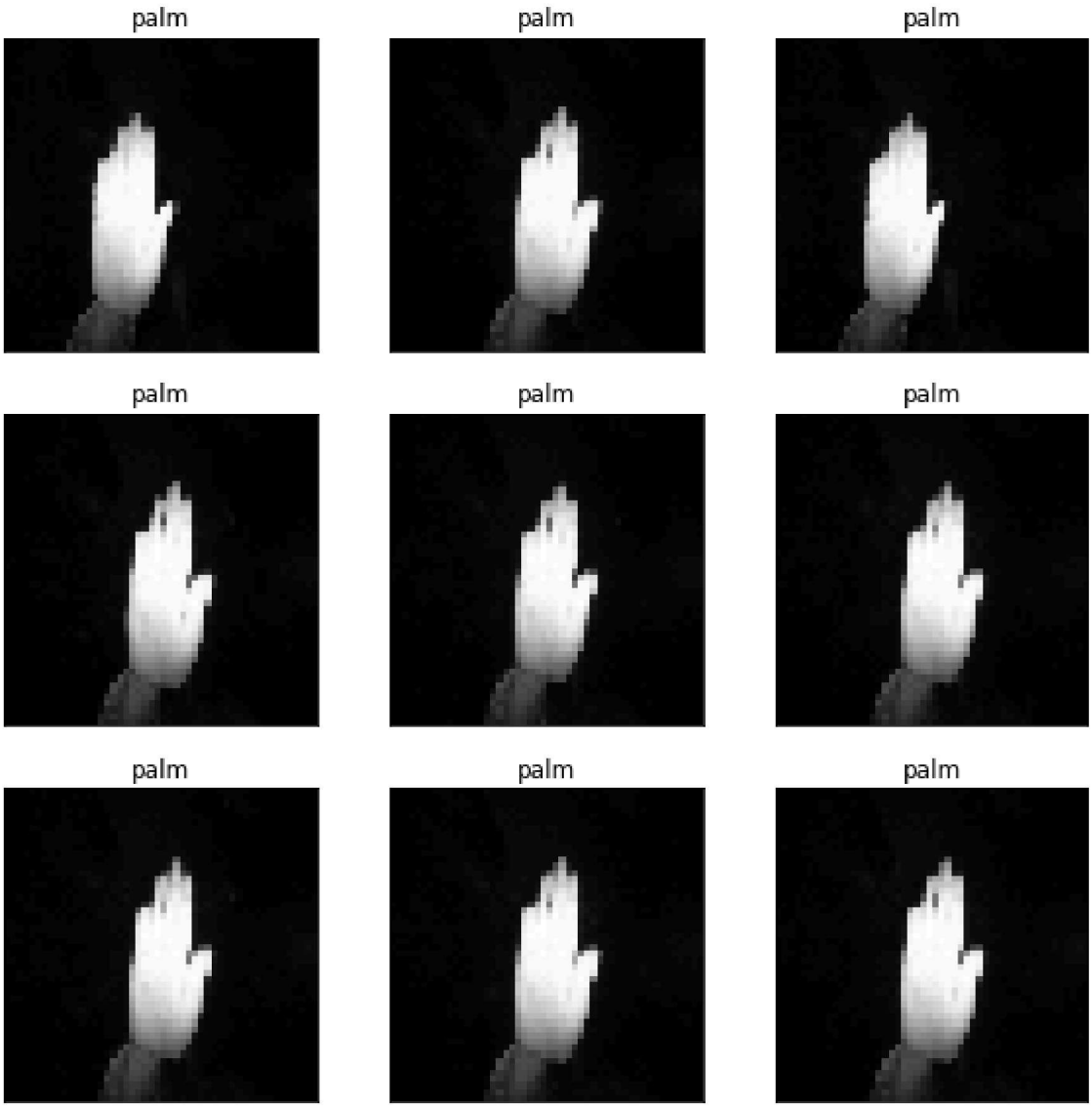
In [82]:
```
#Load the images and their corresponding labels
image_data = []
for dr in os.listdir(data_path):
    for category in CATEGORIES:
        class_index = CATEGORIES.index(category)
        path = os.path.join(data_path, dr, category)
        for img in os.listdir(path):
            try:
                img_arr = cv2.imread(os.path.join(path, img), cv2.IMREAD_GRAYSCALE)
                # Resize the images to IMG_SIZE x IMG_SIZE
                resized_img = cv2.resize(img_arr, (IMG_SIZE, IMG_SIZE))
                image_data.append([resized_img, class_index])
            except Exception as e:
                print(f"Error reading image - {os.path.join(path, img)}")
```

In [84]:
```
# Convert image data to numpy arrays
X = []
y = []

for features, label in image_data:
    X.append(features)
    y.append(label)
```

In [85]:
```
# Convert lists to numpy arrays and add channel dimension
X = np.array(X)
X = np.expand_dims(X, axis=-1)  # Add channel dimension
y = np.array(y)
```

In [86]:
```
# Visualize some sample images
plt.figure(1, figsize=(10,10))
for i in range(1, 10):
    plt.subplot(3, 3, i)
    plt.imshow(image_data[i][0], cmap='gray')
    plt.xticks([])
    plt.yticks([])
    plt.title(CATEGORIES[image_data[i][1]][3:])
plt.show()
```



In [87]:
```
# Shuffle the data
from sklearn.utils import shuffle
X, y = shuffle(X, y, random_state=42)
```

In [88]:
```
# Normalize the pixel values
X = X / 255.0
```

In [89]:
```
# Convert labels into one-hot encoded vectors
from keras.utils import to_categorical
y = to_categorical(y, num_classes=len(CATEGORIES))
```

In [90]:
```
# Split the data into training and testing sets
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_stat
```

In [92]:
```
# Define the CNN model architecture
model = keras.Sequential([
    Conv2D(64, (3, 3), input_shape=(IMG_SIZE, IMG_SIZE, 1)),  # Add channel dimensio
    Activation('relu'),
    MaxPool2D(pool_size=(2, 2)),
    Conv2D(64, (3, 3)),
    Activation('relu'),
    MaxPool2D(pool_size=(2, 2)),
    Flatten(),
    Dense(64),
    Activation('relu'),
```

```
    Dropout(0.5),
    Dense(len(CATEGORIES)),
    Activation('softmax')
])
```

In [93]:
```
# Compile the model
model.compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accuracy'])
```

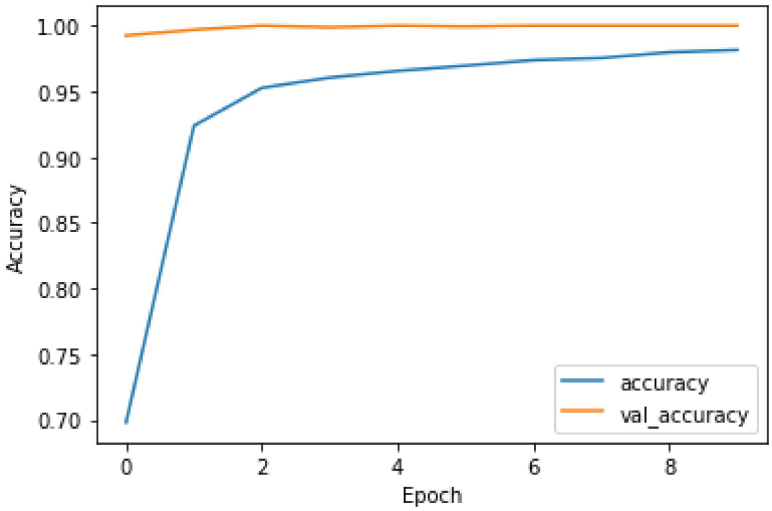
In [94]:
```
# Train the model on the training data
history = model.fit(X_train, y_train, batch_size=32, epochs=10, validation_split=0.1
```

```
Epoch 1/10
450/450 [==============================] - 2s 4ms/step - loss: 0.8634 - accuracy: 0.6
980 - val_loss: 0.0571 - val_accuracy: 0.9925
Epoch 2/10
450/450 [==============================] - 2s 3ms/step - loss: 0.2101 - accuracy: 0.9
238 - val_loss: 0.0138 - val_accuracy: 0.9969
Epoch 3/10
450/450 [==============================] - 2s 3ms/step - loss: 0.1299 - accuracy: 0.9
526 - val_loss: 0.0024 - val_accuracy: 1.0000
Epoch 4/10
450/450 [==============================] - 2s 3ms/step - loss: 0.1018 - accuracy: 0.9
604 - val_loss: 0.0049 - val_accuracy: 0.9987
Epoch 5/10
450/450 [==============================] - 2s 3ms/step - loss: 0.0909 - accuracy: 0.9
656 - val_loss: 9.6944e-04 - val_accuracy: 1.0000
Epoch 6/10
450/450 [==============================] - 2s 3ms/step - loss: 0.0735 - accuracy: 0.9
695 - val_loss: 0.0032 - val_accuracy: 0.9994
Epoch 7/10
450/450 [==============================] - 2s 4ms/step - loss: 0.0688 - accuracy: 0.9
737 - val_loss: 5.0798e-04 - val_accuracy: 1.0000
Epoch 8/10
450/450 [==============================] - 2s 3ms/step - loss: 0.0621 - accuracy: 0.9
753 - val_loss: 2.9358e-04 - val_accuracy: 1.0000
Epoch 9/10
450/450 [==============================] - 2s 4ms/step - loss: 0.0529 - accuracy: 0.9
797 - val_loss: 1.7601e-04 - val_accuracy: 1.0000
Epoch 10/10
450/450 [==============================] - 2s 4ms/step - loss: 0.0482 - accuracy: 0.9
815 - val_loss: 4.6472e-04 - val_accuracy: 1.0000
```

In [95]:
```
# Evaluate the model on the testing data
test_loss, test_acc = model.evaluate(X_test, y_test)
print("Test Accuracy:", test_acc)
```

```
125/125 [==============================] - 0s 2ms/step - loss: 4.7374e-04 - accuracy:
0.9998
Test Accuracy: 0.999750018119812
```

In [96]:
```
# Visualize the training history
plt.plot(history.history['accuracy'], label='accuracy')
plt.plot(history.history['val_accuracy'], label='val_accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend(loc='lower right')
plt.show()
```


1.00
0.95
0.90
0.85
0.80
0.75
0.70
Accuracy
0
2
4
6
8
Epoch
accuracy
val_accuracy