In [3]:

```
import os
import cv2
import numpy as np
from random import shuffle
from zipfile import ZipFile
from PIL import Image
import matplotlib.pyplot as plt
import random
from keras.callbacks import EarlyStopping
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from keras.optimizers import RMSprop,Adam
from tensorflow.keras import layers, models
from keras.models import save_model
from keras.layers import Dense, Dropout, Flatten, Conv2D, MaxPool2D
from tensorflow.keras.utils import to_categorical
```

In [2]:

```
# Reading the data (gestures images)
path = "C:/Users/Aditya Kudva/Downloads/archive (3).zip/leapGestRecog" # Gestures Path
hand_gestures = ["01_palm", "02_l", "03_fist", "04_fist_moved", "05_thumb", "06_index", "07_o
final_data = [] # An empty list to hold the dictionaries for each gesture.
image_size = (150, 150)

for file in range(10): # Looping through the 10 files containing the gestures.
    file_data = os.path.join(path, f"{file:02d}")
    for gesture in hand_gestures: # Looping through the gestures files.
        gestures_img = os.path.join(file_data, gesture)
        if os.path.exists(gestures_img):
            for filename in os.listdir(gestures_img): # Looping through the images in each ge
                if filename.endswith((".png", ".jpg")):
                    image_path = os.path.join(gestures_img, filename)
                    image = cv2.imread(image_path, cv2.IMREAD_GRAYSCALE)
                    if image is not None: # Checking if it's a valid image
                        resized_image = cv2.resize(image, image_size)
                        final_data.append({"gesture": gesture, "image": resized_image})

total_count = len(final_data)
print(f"total data count: {total_count}")
```

```
total data count: 20000
```

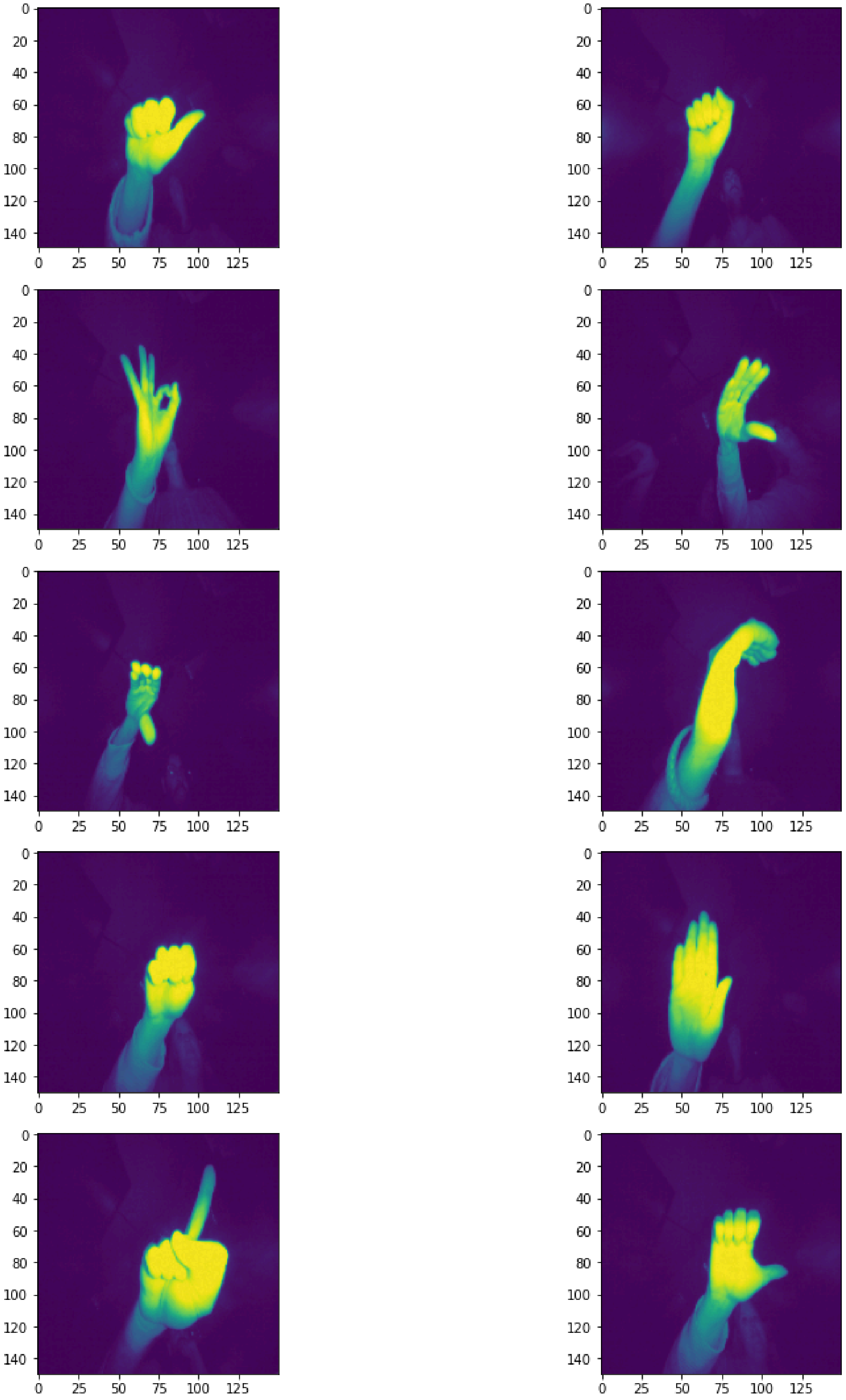
In [3]:

```
images = np.array([item['image'] for item in final_data])
labels = np.array([item['gesture'] for item in final_data])

images = np.array(images, dtype = 'float32')
labels = np.array(labels)
labels = labels.reshape(total_count, 1)
```

In [4]:

```
fig,ax = plt.subplots(5,2)
fig.set_size_inches(15,15)
for i in range(5):
    for j in range (2):
        l = random.randint(0,len(labels))
        ax[i,j].imshow(images[l])
plt.tight_layout()
```


0
20
40
60
80
100
120
140
0
25
50
75
100
125

In [5]:

```
# Converting the labels to numerical representation
label_encoder = LabelEncoder()
labels = label_encoder.fit_transform(labels)
labels = to_categorical(labels)

# Splitting the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(images, labels, test_size = 0.2, random_s
```

```
c:\Users\User\Documents\python\lib\site-packages\sklearn\preprocessing\_label.py:115: DataCo
nversionWarning: A column-vector y was passed when a 1d array was expected. Please change th
e shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [6]:

```
X_train.shape
```

Out[6]:

```
(16000, 150, 150)
```

In [7]:

```
y_train.shape
```

Out[7]:

```
(16000, 10)
```

In [8]:

```
# CNN model
model = models.Sequential()
# 1st Layer
model.add(Conv2D(filters = 15, kernel_size = (5,5),padding = 'Same',
                 activation ='relu', input_shape = (150, 150, 1)))
model.add(MaxPool2D(pool_size = (2,2)))
model.add(Dropout(0.25))

# 2nd layer
model.add(Conv2D(filters = 32, kernel_size = (3,3),padding = 'Same',
                 activation ='relu'))
model.add(MaxPool2D(pool_size = (2,2), strides = (2,2)))
model.add(Dropout(0.25))

# Flatten
model.add(Flatten())

model.add(Dense(512, activation = "relu"))
model.add(Dense(len(hand_gestures), activation = 'softmax'))

# Inialize the optimizer
optimizer = Adam(learning_rate = 0.001, beta_1 = 0.9, beta_2 = 0.999)
# Compile the model
model.compile(optimizer = optimizer, loss = 'categorical_crossentropy', metrics = ['accuracy'

# Early stopping to avoid overfitting
early_stopping = EarlyStopping(monitor = 'val_loss', patience = 1, restore_best_weights = Tru
# Train the model (training history)
history = model.fit(X_train, y_train, epochs = 3, batch_size = 250, validation_data = (X_test

# Evaluate the model
test_loss, test_acc = model.evaluate(X_test, y_test)
print(f"Test Accuracy: {test_acc}")
```

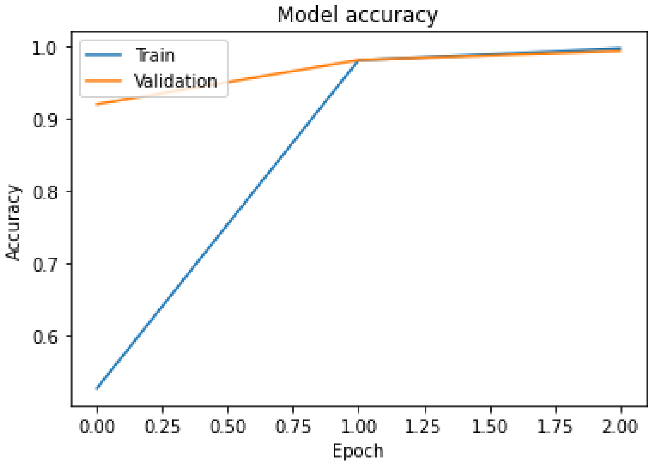
```
Epoch 1/3
64/64 [==============================] - 3848s 60s/step - loss: 49.2367 - accuracy: 0.5278 -
val_loss: 0.4549 - val_accuracy: 0.9195
Epoch 2/3
64/64 [==============================] - 2130s 33s/step - loss: 0.0761 - accuracy: 0.9803 -
val_loss: 0.1067 - val_accuracy: 0.9805
Epoch 3/3
64/64 [==============================] - 2547s 39s/step - loss: 0.0143 - accuracy: 0.9965 -
val_loss: 0.0483 - val_accuracy: 0.9930
125/125 [==============================] - 175s 1s/step - loss: 0.0483 - accuracy: 0.9930
Test Accuracy: 0.9929999709129333
```

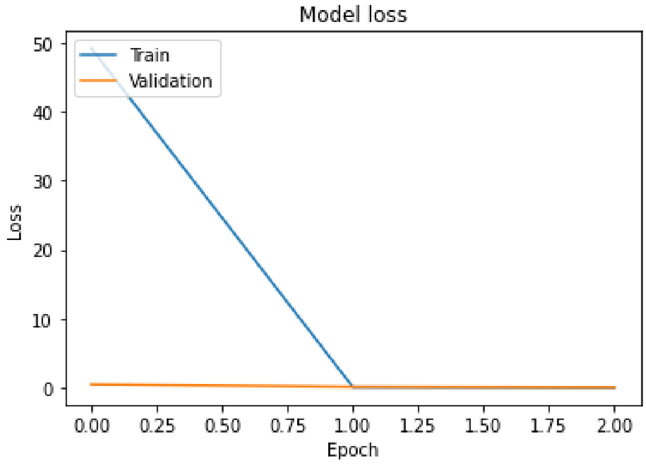
In [9]:

```
# Plotting the learning curves
def plot_learning_curves(history):
    # The training & validation accuracy values
    plt.plot(history.history['accuracy'])
    plt.plot(history.history['val_accuracy'])
    plt.title('Model accuracy')
    plt.ylabel('Accuracy')
    plt.xlabel('Epoch')
    plt.legend(['Train', 'Validation'], loc = 'upper left')
    plt.show()

    # The training & validation loss values
    plt.plot(history.history['loss'])
    plt.plot(history.history['val_loss'])
    plt.title('Model loss')
    plt.ylabel('Loss')
    plt.xlabel('Epoch')
    plt.legend(['Train', 'Validation'], loc = 'upper left')
    plt.show()

# Calling the function
plot_learning_curves(history)
```





In [ ]:

```
# Save the model
model.save('C:/Users/Aditya Kudva/Downloads/archive (3).zip/leapGestRecog/CNN model_final.h5'
```