

| Hand Landmark Detection Experiments

| To. Professor

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1. Data preprocessing
2. Comparison of the results

1. Data preprocessing

- Hands

- 1) MIDDLE_FINGER_MCP_L(R)X,
MIDDLE_FINGER_PIP_L(R)X,
MIDDLE_FINGER_DIP_L(R)X,
MIDDLE_FINGER_TIP_L(R)X
- 2) MIDDLE_FINGER_MCP_L(R)X

- Left hand

- 3) MIDDLE_FINGER_MCP_LX,
MIDDLE_FINGER_PIP_LX,
MIDDLE_FINGER_DIP_LX,
MIDDLE_FINGER_TIP_LX
- 4) MIDDLE_FINGER_MCP_LX

A	B	C	D	E	F	G	H
MIDDLE_FINGER_MCP_LX	MIDDLE_FINGER_PIP_LX	MIDDLE_FINGER_DIP_LX	MIDDLE_FINGER_TIP_LX	MIDDLE_FINGER_MCP_RX	MIDDLE_FINGER_PIP_RX	MIDDLE_FINGER_DIP_RX	MIDDLE_FINGER_TIP_RX
792.0715332	782.1463013	775.5525208	774.2513275	460.4141998	458.9736557	466.1525345	472.3816299
792.0715332	782.4746704	776.0063171	774.0420532	460.9999466	456.1603165	463.0604553	469.8832703
791.5390015	782.5287628	777.0881653	777.0807648	460.3638458	454.9031448	462.0224762	468.4103775
791.5320587	782.3477173	777.0161438	776.6869354	460.361557	456.1800003	464.0202713	469.6307755
792.0436859	782.8017426	776.2223053	774.4185638	462.6716232	456.9490051	464.2858124	470.0968933
792.0436859	782.8017426	776.2223053	774.4185638	462.6716232	456.9490051	464.2858124	470.0968933
792.0713043	782.9406738	776.0401154	774.733429	462.027092	459.3443298	467.3751831	472.4959183
462.3471069	455.6173706	464.2012787	471.8212509	792.1767426	782.9836273	776.7145538	775.4013062
792.1253204	783.197403	776.9129181	775.8071899	460.8595657	456.4005661	466.3761902	474.2189407
791.9091797	783.208847	776.4504242	775.0447845	459.6366882	454.4963837	465.4005432	474.3032074
791.6321564	782.3054504	775.8274078	774.2516327	460.5712891	454.2150497	465.2984238	474.8935318
791.6321564	782.3054504	775.8274078	774.2516327	460.5712891	454.2150497	465.2984238	474.8935318
791.4840698	782.3464966	775.794754	774.3817139	460.2564621	457.2415924	467.2209167	475.5849457
791.7612457	782.3852539	776.5953827	775.5981445	459.7860718	454.9981308	464.9563217	473.5411453
791.8099976	782.8125763	776.9517517	775.6623077	461.4528656	455.4842758	464.7673798	474.032402
792.116394	782.8869629	776.4196014	774.8455811	466.0401154	461.9869614	472.3565292	482.2867203
792.0761108	782.4521637	775.8324432	773.8095856	473.1424713	467.7035522	477.1802521	486.9163132
792.0761108	782.4521637	775.8324432	773.8095856	473.1424713	467.7035522	477.1802521	486.9163132
791.752243	782.6222992	775.8952332	773.8021851	478.0731583	477.5016022	486.3164139	495.0822067
792.1231079	782.461853	775.4364014	773.2946014	485.6835556	489.214592	497.9719925	505.5461884
791.5228271	782.3390961	775.9118652	773.9373779	491.5335083	497.040863	506.8690491	513.8412857
497.0732117	500.3937531	512.9537964	523.979187	791.9593048	782.6304626	776.164856	774.7048187
499.864502	502.5288391	512.5699234	521.9066238	792.433548	782.8912354	776.2283325	775.2890778
499.864502	502.5288391	512.5699234	521.9066238	792.433548	782.8912354	776.2283325	775.2890778
499.8698807	501.9042587	512.3855972	522.5361633	792.097702	783.0460358	776.7201233	776.0467529
498.8507462	501.1897659	512.6781845	522.2292328	791.8486786	782.813797	776.2615967	775.2387238
500.2666473	501.7518234	512.521553	521.6240692	792.0121002	782.3039246	776.5420532	776.4131927
500.7865524	500.6198883	509.2269135	516.6589355	792.7781677	783.5939789	776.5053558	775.0933075
501.3058472	501.918335	508.2952118	514.5215988	792.2616577	782.883606	775.3868103	773.320694
501.3058472	501.918335	508.2952118	514.5215988	792.2616577	782.883606	775.3868103	773.320694
502.4193954	502.5608063	508.2546997	514.0649414	792.4634552	783.3364868	776.3054657	774.2378998
502.5062943	502.2803879	508.1975555	513.7279892	792.9377747	783.4965515	776.3330078	774.1588593
502.9912949	502.7827835	508.3984375	514.2190933	792.5621033	783.6847687	776.5162659	773.7792969

2. Comparison of the accuracy

1. 양손 - LSTM_prediction_accuracy

- 1) MIDDLE_FINGER_MCP_L(R)X,
MIDDLE_FINGER_PIP_L(R)X,
MIDDLE_FINGER_DIP_L(R)X,
MIDDLE_FINGER_TIP_L(R)X

```
In [50]: 1 LSTM_prediction = LSTM_model_Run(X_train, y_train, X_test, my_LSTM_model)
Epoch 42/50
6/6 [=====] - 1s 194ms/step - loss: 0.1465 - accuracy: 0.0036
Epoch 43/50
6/6 [=====] - 2s 305ms/step - loss: 0.1461 - accuracy: 0.0030
Epoch 44/50
6/6 [=====] - 1s 227ms/step - loss: 0.1467 - accuracy: 0.0039
Epoch 45/50
6/6 [=====] - 2s 257ms/step - loss: 0.1466 - accuracy: 0.0030
Epoch 46/50
6/6 [=====] - 2s 261ms/step - loss: 0.1460 - accuracy: 0.0041
Epoch 47/50
6/6 [=====] - 2s 301ms/step - loss: 0.1465 - accuracy: 0.0031
Epoch 48/50
6/6 [=====] - 1s 265ms/step - loss: 0.1458 - accuracy: 0.0029
Epoch 49/50
6/6 [=====] - 2s 286ms/step - loss: 0.1462 - accuracy: 0.0030
Epoch 50/50
6/6 [=====] - 2s 283ms/step - loss: 0.1470 - accuracy: 0.0034
2/2 [=====] - 0s 43ms/step
```

1. 양손 - Test_accuracy

- 1) MIDDLE_FINGER_MCP_L(R)X,
MIDDLE_FINGER_PIP_L(R)X,
MIDDLE_FINGER_DIP_L(R)X,
MIDDLE_FINGER_TIP_L(R)X

6-2. 정확도 수치 비교

```
In [60]: 1 from math import sqrt
2 from sklearn.metrics import mean_squared_error, r2_score, explained_variance_score
3
4 score = my_LSTM_model.evaluate(X_test, y_test)
5 print("test loss, test acc:", score)

2/2 [=====] - 0s 24ms/step - loss: 0.1592 - accuracy: 0.0116
test loss, test acc: [0.15920588374137878, 0.011613475158810616]
```

2. Comparison of the accuracy

2. 양손 - LSTM_prediction_accuracy

2) MIDDLE_FINGER_MCP_L(R)X

- using only one joint

```
0/0 [-----] - 0s 34ms/step - loss: 0.1433 - accuracy: 0.0033
Epoch 45/50
6/6 [=====] - 0s 38ms/step - loss: 0.1442 - accuracy: 0.0041
Epoch 46/50
6/6 [=====] - 0s 50ms/step - loss: 0.1446 - accuracy: 0.0035
Epoch 47/50
6/6 [=====] - 0s 45ms/step - loss: 0.1435 - accuracy: 0.0033
Epoch 48/50
6/6 [=====] - 0s 36ms/step - loss: 0.1418 - accuracy: 0.0036
Epoch 49/50
6/6 [=====] - 0s 45ms/step - loss: 0.1421 - accuracy: 0.0035
Epoch 50/50
6/6 [=====] - 0s 38ms/step - loss: 0.1420 - accuracy: 0.0034
2/2 [=====] - 0s 10ms/step
[LSTM_prediction] : [[0.41962337]
```

2. 양손 - Test_accuracy

2) MIDDLE_FINGER_MCP_L(R)X

- using only one joint

6-2. 정확도 수치 비교

```
1 from math import sqrt
2 from sklearn.metrics import mean_squared_error, r2_score, explained_variance_score
3
4 score = my_LSTM_model.evaluate(X_test, y_test)
5 print("test loss, test acc:", score)
```

```
2/2 [=====] - 0s 18ms/step - loss: 0.1518 - accuracy: 0.0082
test loss, test acc: [0.15178526937961578, 0.00815602857619524]
```

2. Comparison of the accuracy

3. 왼손 - LSTM_prediction_accuracy

3) MIDDLE_FINGER_MCP_LX,
MIDDLE_FINGER_PIP_LX,
MIDDLE_FINGER_DIP_LX,
MIDDLE_FINGER_TIP_LX

```
Epoch 45/50  
6/6 [=====] - 1s 131ms/step - loss: 0.1412 - accuracy: 0.0043  
Epoch 46/50  
6/6 [=====] - 1s 158ms/step - loss: 0.1463 - accuracy: 0.0053  
Epoch 47/50  
6/6 [=====] - 0s 86ms/step - loss: 0.1402 - accuracy: 0.0053  
Epoch 48/50  
6/6 [=====] - 1s 86ms/step - loss: 0.1415 - accuracy: 0.0053  
Epoch 49/50  
6/6 [=====] - 1s 82ms/step - loss: 0.1416 - accuracy: 0.0038  
Epoch 50/50  
6/6 [=====] - 1s 124ms/step - loss: 0.1390 - accuracy: 0.0039  
2/2 [=====] - 0s 31ms/step  
[LSTM_prediction] : [[0.26399016]
```

3. 왼손 - Test_accuracy

3) MIDDLE_FINGER_MCP_LX,
MIDDLE_FINGER_PIP_LX,
MIDDLE_FINGER_DIP_LX,
MIDDLE_FINGER_TIP_LX

6-2. 정확도 수치 비교

```
35] : 1 from math import sqrt  
2 from sklearn.metrics import mean_squared_error, r2_score, explained_variance_score  
3  
4 score = my_LSTM_model.evaluate(X_test, y_test)  
5 print("test loss, test acc:", score)
```

```
2/2 [=====] - 0s 21ms/step - loss: 0.1433 - accuracy: 0.0069  
test loss, test acc: [0.14329998195171356, 0.006914893630892038]
```


2. Comparison of the accuracy

4. 왼손 - LSTM_prediction_accuracy

4) MIDDLE_FINGER_MCP_LX

- using only one joint

```
In [18]: 1 LSTM_prediction = LSTM_model_Run(X_train, y_train, X_test, my_LSTM_model)
Epoch 44/50
6/6 [=====] - 0s 45ms/step - loss: 0.1423 - accuracy: 0.0040
Epoch 45/50
6/6 [=====] - 0s 51ms/step - loss: 0.1423 - accuracy: 0.0043
Epoch 46/50
6/6 [=====] - 0s 41ms/step - loss: 0.1436 - accuracy: 0.0040
Epoch 47/50
6/6 [=====] - 0s 56ms/step - loss: 0.1422 - accuracy: 0.0054
Epoch 48/50
6/6 [=====] - 0s 50ms/step - loss: 0.1432 - accuracy: 0.0040
Epoch 49/50
6/6 [=====] - 0s 40ms/step - loss: 0.1490 - accuracy: 0.0060
Epoch 50/50
6/6 [=====] - 0s 45ms/step - loss: 0.1444 - accuracy: 0.0040
2/2 [=====] - 0s 8ms/step
[LSTM_prediction] : [[0.40208352]
In 5626531 1
```

4. 왼손 - Test_accuracy

4) MIDDLE_FINGER_MCP_LX

- using only one joint

6-2. 정확도 수치 비교

```
1 from math import sqrt
2 from sklearn.metrics import mean_squared_error, r2_score, explained_variance_score
3
4 score = my_LSTM_model.evaluate(X_test, y_test)
5 print("test loss, test acc:", score)
```

```
2/2 [=====] - 0s 18ms/step - loss: 0.1536 - accuracy: 0.0064
test loss, test acc: [0.15364673733711243, 0.006382978521287441]
```

2. Comparison of the accuracy

1. Middle finger(L+R)

- train_acc: 0.0034
- train_loss: 0.1470
- test_acc: 0.0116
- test_loss: 0.1592

3. Middle finger(L)

- train_acc: 0.0039
- train_loss: 0.1390
- test_acc: 0.0069
- test_loss: 0.1433

2. Middle finger MCP(L+R)

- train_acc: 0.0034 - using only one joint
- train_loss: 0.1420
- test_acc: 0.0082
- test_loss: 0.1518

4. Middle finger MCP(L)

- train_acc: 0.0040 - using only one joint
- train_loss: 0.1444
- test_acc: 0.0064
- test_loss: 0.1536

* the train epoch sets up 50.