Cross-People Mobile-Phone based Airwriting Character Recognition

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Supposing

When you are walking, suddenly come up with a wonderful idea. Would you like to ...

• Go back to the office, find the draft paper and pen and write it down?

• Turn on the phone, enter the password, find the notepad from many APPs, and finally type and record?

• Pick up the phone and write directly in the air?

Airwriting can make the third approach a reality!
Airwriting

- Airwriting refers to writing letters with hand or finger movements in a free space.
- Airwriting is especially useful for user interfaces that do not allow the user to type on a keyboard or write on a trackpad or touchscreen, or for text input for smart system control, among many applications.

Figure: Airwriting
The machine learning method is very effective to solve the Airwriting problem, but there are still several challenges:

- **Non-IID**: Due to different people’s habits and equipment, the data of different people do not obey the same distribution -> Fine-tuning from the base model

- **Small Sample**: Because there are many possible situations, the data needs to be collected by the user personally, and the user will be tired after collecting it for a period of time, it is difficult to obtain the data -> Transfer Learning
Data preprocessing

- Define the square of acceleration as the energy
- Segmentation based on writing energy: changes in energy are more sensitive at the beginning and end of writing numbers

Figure: Energy of acceleration
Network

- CNNs are able to learn local higher-level features from spatial data
- RNNs are specialized for sequential modeling
- AdaBNs can be used for knowledge transfer

Figure: CNN-BLSTM-AdaBN
AdaBN

- Perform batch normalization for training domain and test domain
- Domain specific normalization mitigates the domain shift issue

Figure: AdnBN
Base Model

- Training using more than 20,000 pieces of data
- Achieve more than 99% accuracy

Figure: Confusion matrix of base model
Migrate to small datasets

- The size of the target data set is only 0.003% of the base model training set
- Our method is able to improve the performance of the model by 10% on average

<table>
<thead>
<tr>
<th>Target</th>
<th>Base Model</th>
<th>Transfer</th>
<th>Increase</th>
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<tr>
<td>10</td>
<td>75.59%</td>
<td>81.2%</td>
<td>5.61%</td>
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</table>
Conclusion

- We build an Airwriting recognition system on mobile phone.
- Using enough data for training, our model can achieve an accuracy of over 99%.
- When the new scene training set is only 0.003% of the base model, we can increase the performance of the base model in the corresponding scene by an average of 10%.