Wireless Localisation in WiFi using Novel Deep Architectures

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Introduction :

Aim: Indoor Localisation based on commodity WiFi equipment.
Type: Active localisation.
Media: Channel state information (CSI)
Scheme: Neural network, supervised learning
Difficulties: Feature extraction and network architectures under complex multipath effect.

Experiments :

Experimental area: Indoor office (6.5m * 2.5m)
CSI rate: 500Hz
Label collection: Opti-track system composed of cameras
Access point: 3
Target tag: curvilinear motions

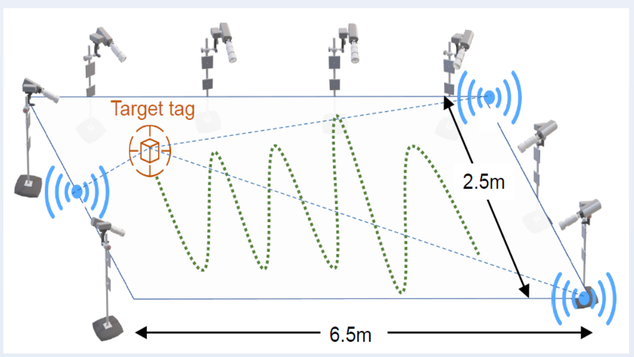
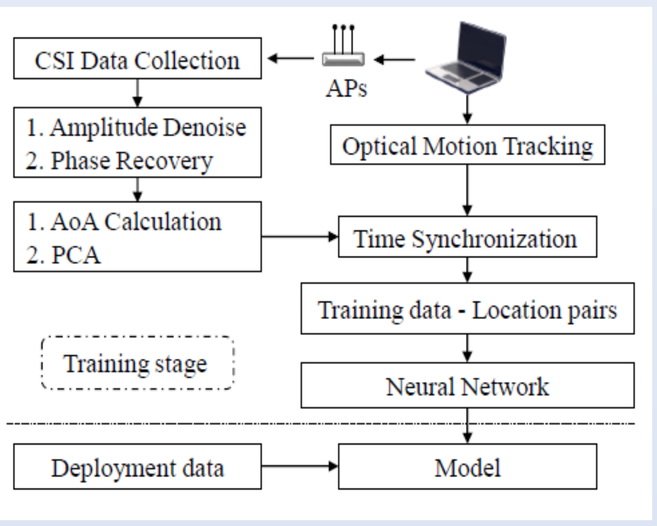


Figure 1: Experiment setup

Figure 2: Real office environment

NN architectures :

1. Shallow neural network (SNN) based scheme



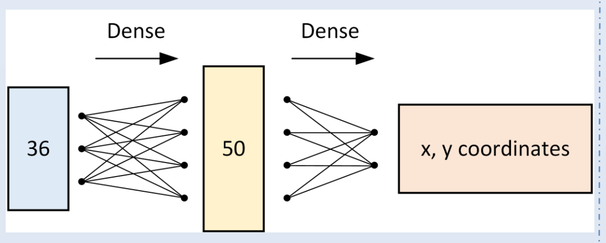


Figure 3: Process diagram of signal processing and training(left); SNN architecture(right)

2. Convolutional neural network (CNN) based scheme

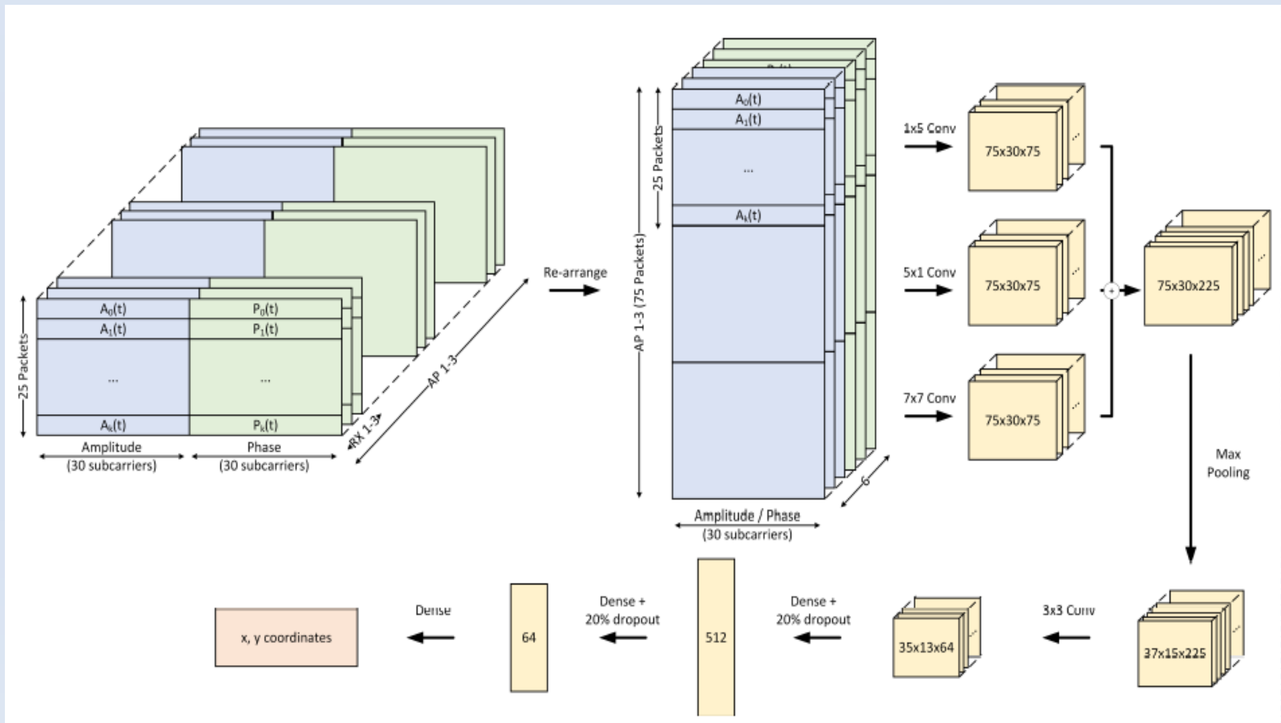


Figure 4: Neural network architecture of CNN

3. Long-short term memory (LSTM) based scheme

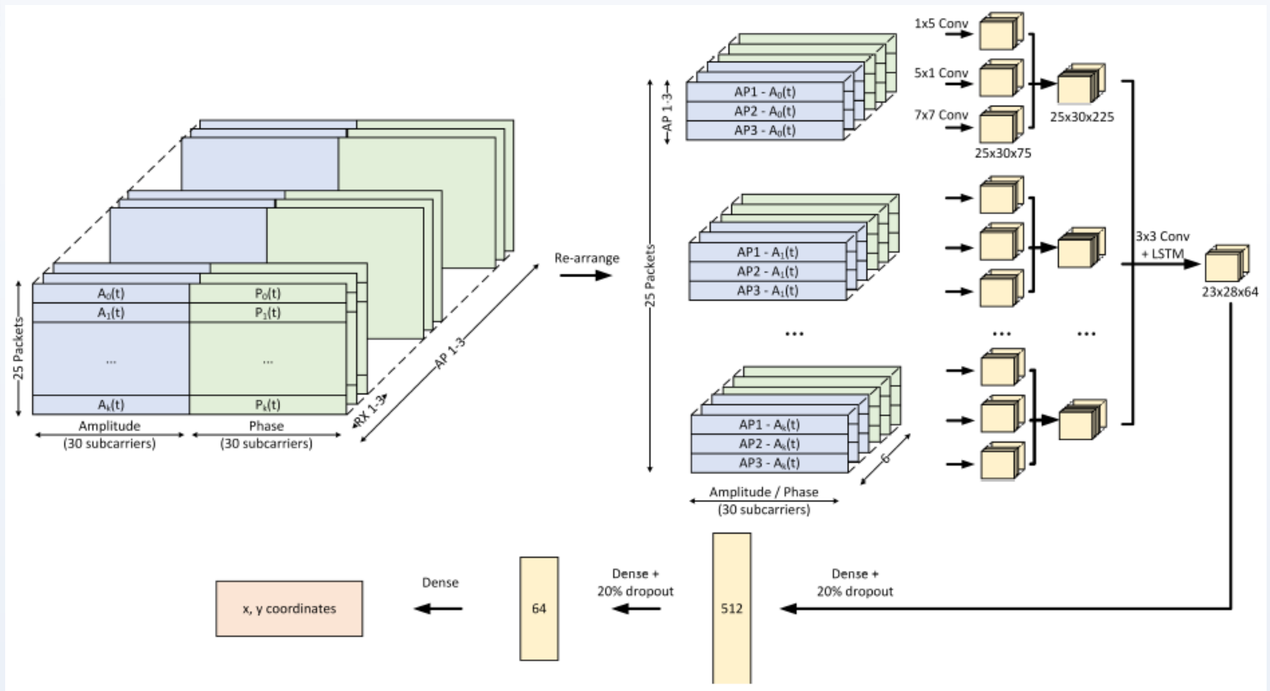


Figure 5: Neural network architecture of LSTM

Results :

1. Performance Evaluation

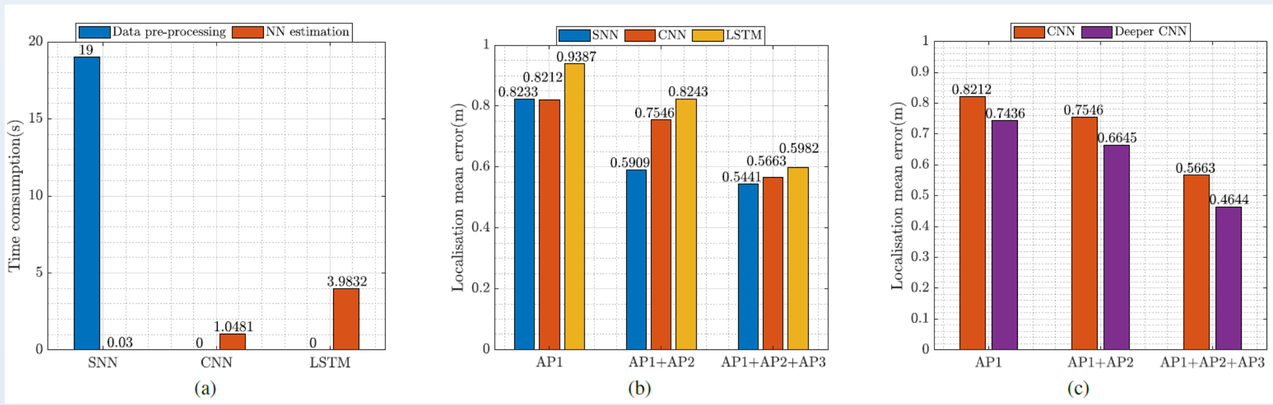
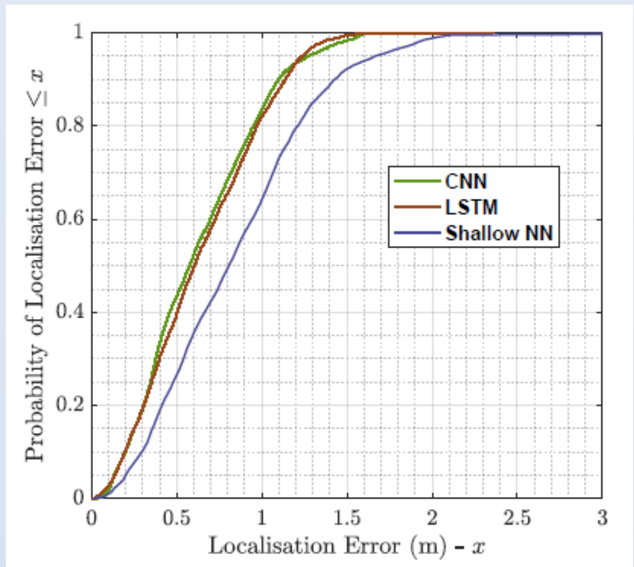


Figure 6: (a) Inference time comparison (1000 samples); (b) Accuracy comparison between the SNN, CNN and LSTM models under different AP combinations; (c) Accuracy comparison between the two CNN models under different AP combinations

2. Special Use-case: Non-Constant Velocity Scenario and ablation study



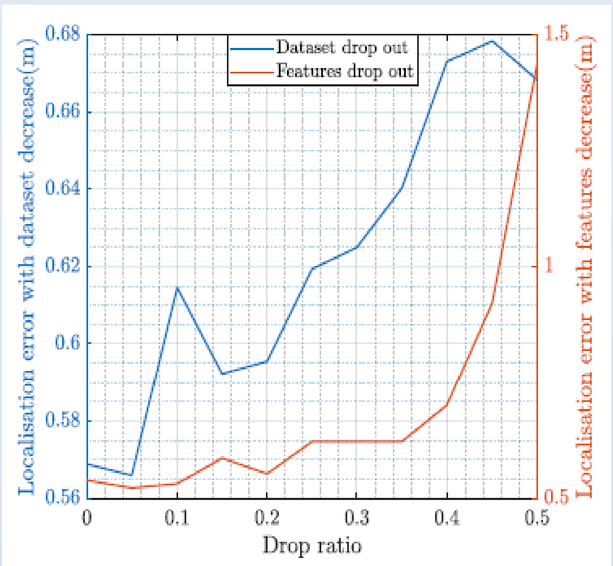


Figure 7: The localisation error CDF of the NN models in the special scenario. The LSTM model is close to the CNN in accuracy and better than the SNN (left); Ablation study for various training data (blue) and feature (red) sizes (right).

Conclusions :

The handcrafted features extraction in SNN is time consuming.

CNN and LSTM can realise localisation via CSI raw data directly, but the LSTM does not present extra advantages on increase localisation accuracy.

In a nonconstant speed motion, the CNN shows better generalisation ability.

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