Deep Learning-Based Compressed Sensing for Mobile Device-Derived Sensor Data

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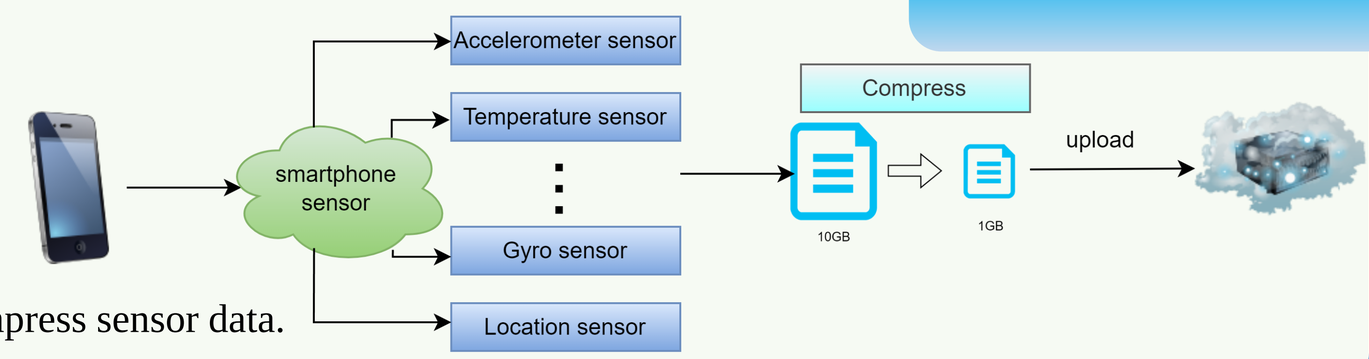
Background

- **Massive data accumulate on smartphones and uploaded to severs daily**
- **Traditional data compression methods are time-consuming and have low reconstruction performances.**



Purpose: Use deep compressed sensing method to compress sensor data.

Methods

Unlike traditional compressed sensing methods, we designed a network named Mob-ISTA-1DNet to replace the measurement and sparse matrices.

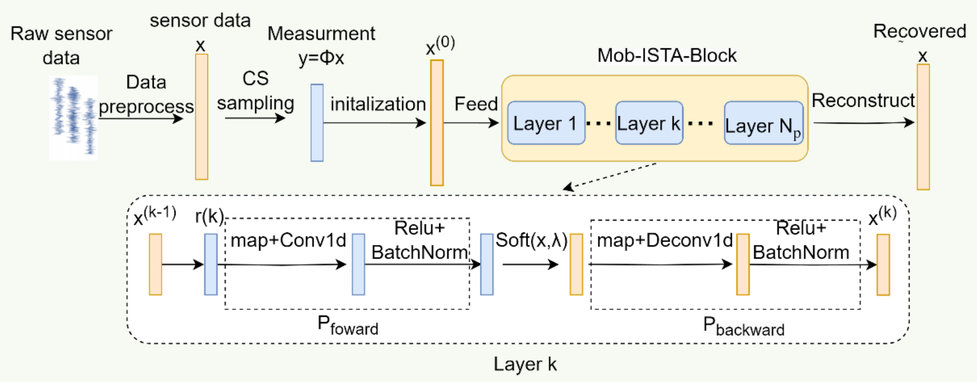


Figure: The architecture of Mob-ISTA-1DNet

Our preliminary experiments found that MSE is not so suitable for acceleration data reconstruction. Meanwhile, the relative error and correlation coefficient are often used as evaluation metrics for compression and reconstruction work; hence, we combined MSE, relative error and correlation coefficient to design a loss function.

$$\mathcal{L} = w\ell + p\zeta + q\gamma$$

$$= w\frac{1}{n}\sum_{i=1}^{N}(x_i - a_i)^2 + p\frac{1}{n}\sum \|\psi\psi^T x_i - x_i\|_2^2 +$$

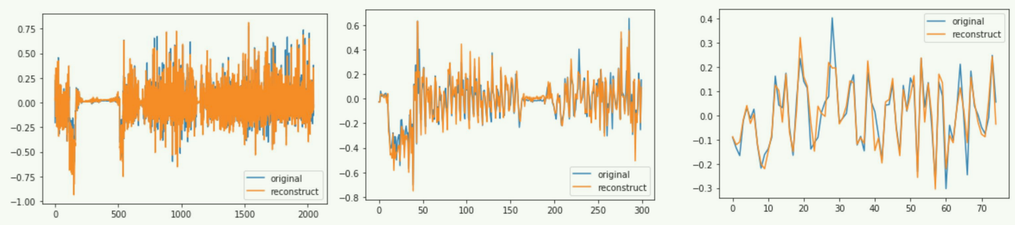
$$q(1 - \frac{1}{n}\sum \frac{\sum_{i=1}^{N}(x_i - \tilde{x})(a_i - \tilde{a})}{\sqrt{\sum_{i=1}^{N}(x_i - \tilde{x})^2}\sqrt{\sum_{i=1}^{N}(a_i - \tilde{a})^2}})$$

Experiments and results

We collected acceleration data by 5 Hz from 100 users with our AWARE framework-based iOS mobile sensing application. In this experiment, we obtained 10,000 signal segments for every user from raw acceleration data by the sliding window (10 seconds) strategy.

Aware framework

Metrics	MSE		CC	
Compression Rate	0.5	0.1	0.5	0.1
OMP	0.05	0.08	0.31	0.33
SP	0.02	0.03	0.22	0.31
ISTA	0.05	0.06	0.40	0.43
ISTA-1DNet	0.02	0.03	0.20	0.22
Mob-ISTA-1DNet	**0.01**	**0.02**	**0.15**	**0.18**



7min 1min 15s

Figure: Examples of comparison and reconstruction results.

Conclusion

- Designed a loss function that works for both sensor data compression and reconstruction
- Implement compression and reconstruction on sensor data by designing our model named Mob-ISTA-1DNet.

On-going

- Organizing a collection experiment on smartwatch;
- Using federated learning to address the high variability across different users;
- Exploring the combination of various sensor data to enhance compression performance