Convolutional Compressed Sensing for Smartphone Acceleration Data Compression

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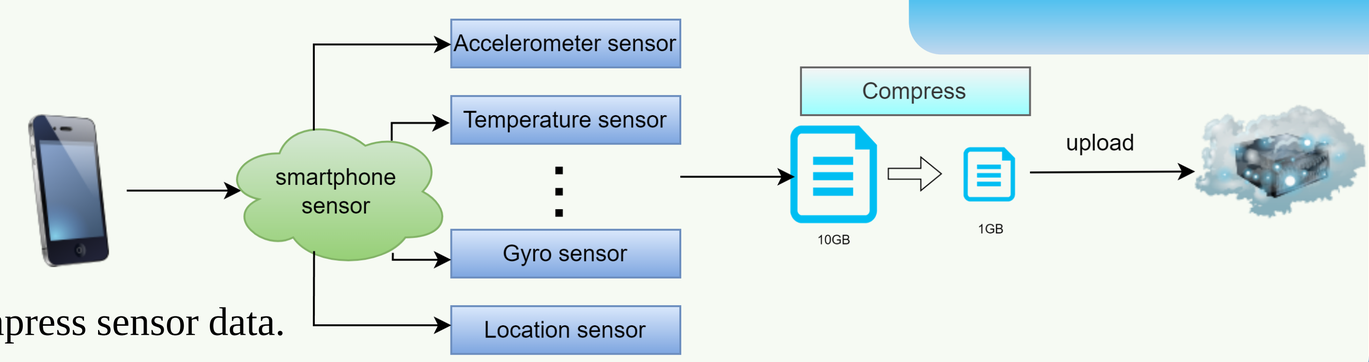
Background

- **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 use deep neural networks to replace the measurement and sparse matrices.

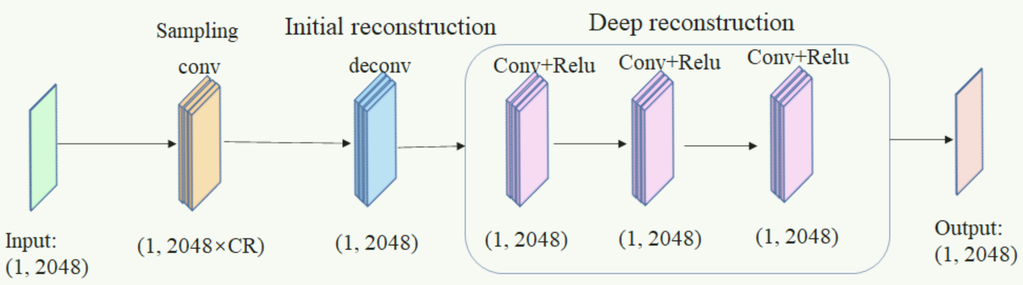


Figure: The architecture of compression and reconstruction network. CR means compression ratio.

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.

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

$$= w\frac{1}{n}\sum_{i=1}^{N}(y_i - a_i)^2 + p\frac{1}{n}\sum\frac{\|y-a\|_2}{\|y\|_2} +$$

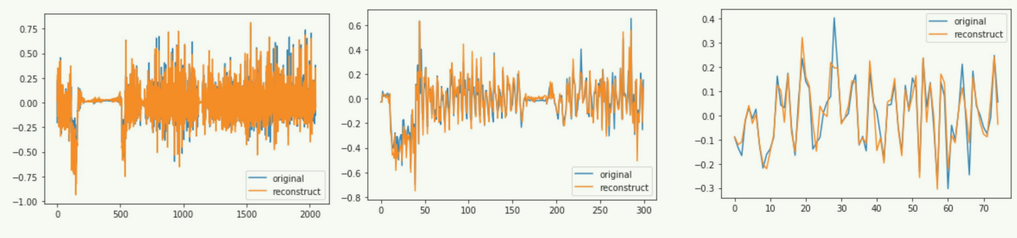
$$q(1 - \frac{1}{n}\sum\frac{\sum_{i=1}^{N}(y_i-\tilde{y})(a_i-\tilde{a})}{\sqrt{\sum_{i=1}^{N}(y_i-\tilde{y})^2}\sqrt{\sum_{i=1}^{N}(a_i-\tilde{a})^2}})$$

Experiments and results

We collected acceleration data by 5 Hz from dozens of 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

Method	Loss(CR 0.5)	Loss(CR 0.1)
OMP	0.79	0.95
SP	0.74	0.95
CNN Auto-encoder	0.28	0.68
CNN CS	**0.28**	**0.67**



7min 1min 15s

Figure: Examples of comparison and reconstruction results.

Conclusion

- Implement compression and reconstruction on sensor data by designing a CNN network based on compressed sensing.
- Improve reconstruction performance and reduce the reconstruction time over conventional methods

On-going

- Organizing a large-scale data collection experiment;
- Designing state-of-the-art network such as transformers;
- Exploring the combination of various sensor data to enhance compression performance