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Research on the Transmission Optimization Schemes of User Side Power Consumption Information

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Introduction

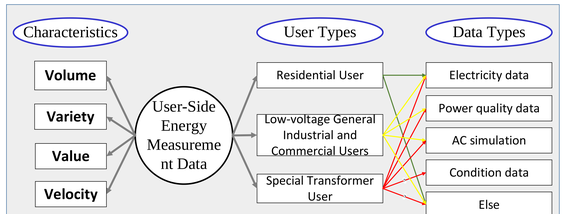
With the construction of the global energy internet and the rapid development of renewable energy technologies such as wind and light, integrated energy has become the focus of development. As an important part of building energy internet , the user-side electricity consumption information collection system is a concentrated display of intelligent measurement technology, which is used to collect the electricity consumption information of all users, and to count and process the collected data.

Purpose

- The current user-side integrated energy measurement technology is not yet mature, the terminal application of intelligent meters is not deep enough, and the communication network architecture has not yet been formed, which brings certain difficulties to the development and utilization of integrated energy.
- At the same time, the types and quantities of user-side measurement equipment are increasing explosively. More and more devices need to be connected to the user-side energy internet, the requirements for communication systems are becoming higher and higher.
- In response to these problems, this paper proposes an object-oriented communication protocol architecture by studying the characteristics and practical significance of user-side integrated energy measurement data. Then, a user-side information compression scheme is proposed, which can reduce the storage pressure of the system and improve the transmission efficiency.

Characteristics

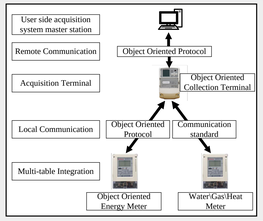
The user-side comprehensive energy measurement data has the characteristics of '4V': Volume, Variety, Value, and Velocity.



Picture 1 Characteristics of User-Side Energy Measurement Data.

Architecture

The user-side power consumption information collection system currently widely uses local communication protocols and remote communication protocols. Now, object-oriented modeling methods and technologies are used to abstract general business models to form an object-oriented protocol (DL/T 698.45), unified remote and local communication data exchange protocols, unified data formats, and greatly improved data The exchange's high efficiency, flexible scalability and data traceability have played an important role in the construction and development of the collection system.



Picture 1 Object-oriented Communication Protocol Architecture for User Side Energy Measurement.

Methods

According to the above analysis, user-side power consumption data has the 4V characteristics. Therefore, in order to reduce the communication burden and improve the utilization rate of system resources, exploring information compression technology has become the core issue of current research. After the acquisition device performs signal conditioning such as buffering and filtering on the signal, the ideal power signal is approximately a sinusoidal signal with extremely high compression quality.

Some experts have proposed the theory of Compressed Sensing (CS) which can be achieved by collecting less data and reconstructing a more complete signal under the condition of much smaller than the Nyquist sampling rate. It points out that as long as the signal is sparse in a certain transform domain, it is possible to use an observation matrix related to the transform base to project the transformed high-dimensional signal onto a low-dimensional space, and then solve an optimization problem from these Reconstructing the original signal with a high probability in a small number of projections can prove that such projections contain enough information to reconstruct the signal.

Input : observation matrix Φ , observation value y , sparsity K	
Output : Recovery signal $\hat{x}$	
Step 1	Initialized residuals $r_0 = y$, index sets $\Lambda_0 = \varnothing$, atomic sets $\Phi_0 = \varnothing$, iterations $t = 1$;
Step 2	Find index λ_t to satisfy $\lambda_t = \arg\max_{j=1,\ldots,N} \left\langle r_{t-1}, \phi_j \right\rangle$;
Step 3	Update the index set $\Lambda_t = \Lambda_{t-1} \cup \{\lambda_t\}$, update the atomic set $\Phi_t = [\Phi_{t-1}, \phi_t]$;
Step 4	Update $x_t = \arg\max_x \left\| y - \Phi_t x \right\|_2$, update residuals $r_t = y - \Phi_t x_t$;
Step 5	If $t < K$, $t = t + 1$, return to step 2; If $t \geq K$, stop iteration, output signal $\hat{x}$

TABLE I. STEPS OF OMP-CS RECONSTRUCTION ALGORITHM

Feasibility & Simulations

As shown in Fig.3, the Fourier analysis of the original signal shows that although the signal is not sparse in the time domain, there are only a few large coefficient values and a large number of small coefficient values in the frequency domain. Therefore, the signal is sparse in the frequency domain. Use compressed sensing theory to compress and restore power signals.

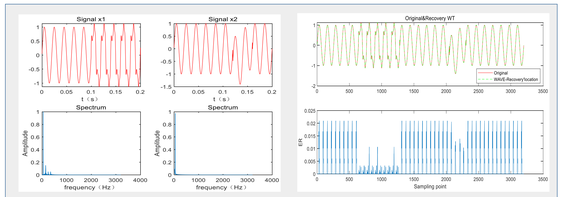


Fig.3 Time domain and frequency domain diagrams of the signal

Fig.4 Comparison of Original Signal and Reconstructed Signal by WT

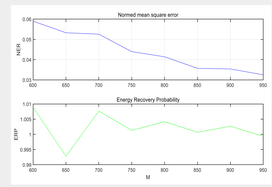


Fig.6 MSE&ERP performance analysis under different observation dimensions

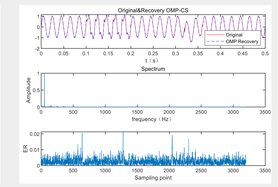


Fig.5 Comparison of Original Signal &Reconstructed Signal by OMP-CS

Conclusions

This scheme can obtain relatively more advantages in compression efficiency, which is conducive to the transmission of large data volume and unobvious operating data, and the system resources are saved. However, due to the limitations of lossy compression, the performance of reconstruction accuracy is not good, so subsequent research can consider combining lossy compression and lossless compression algorithms to improve its shortcomings.