AI-Powered Digital Twin for Smart Battery Management in Renewable Microgrids.

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PROBLEM STATEMENT

- Renewable microgrids face instability due to intermittent solar/wind energy.
- Traditional battery management lacks real-time optimization and adaptability.
- Need for intelligent systems to enhance efficiency, reliability, and cost-effectiveness.

METHODOLOGY

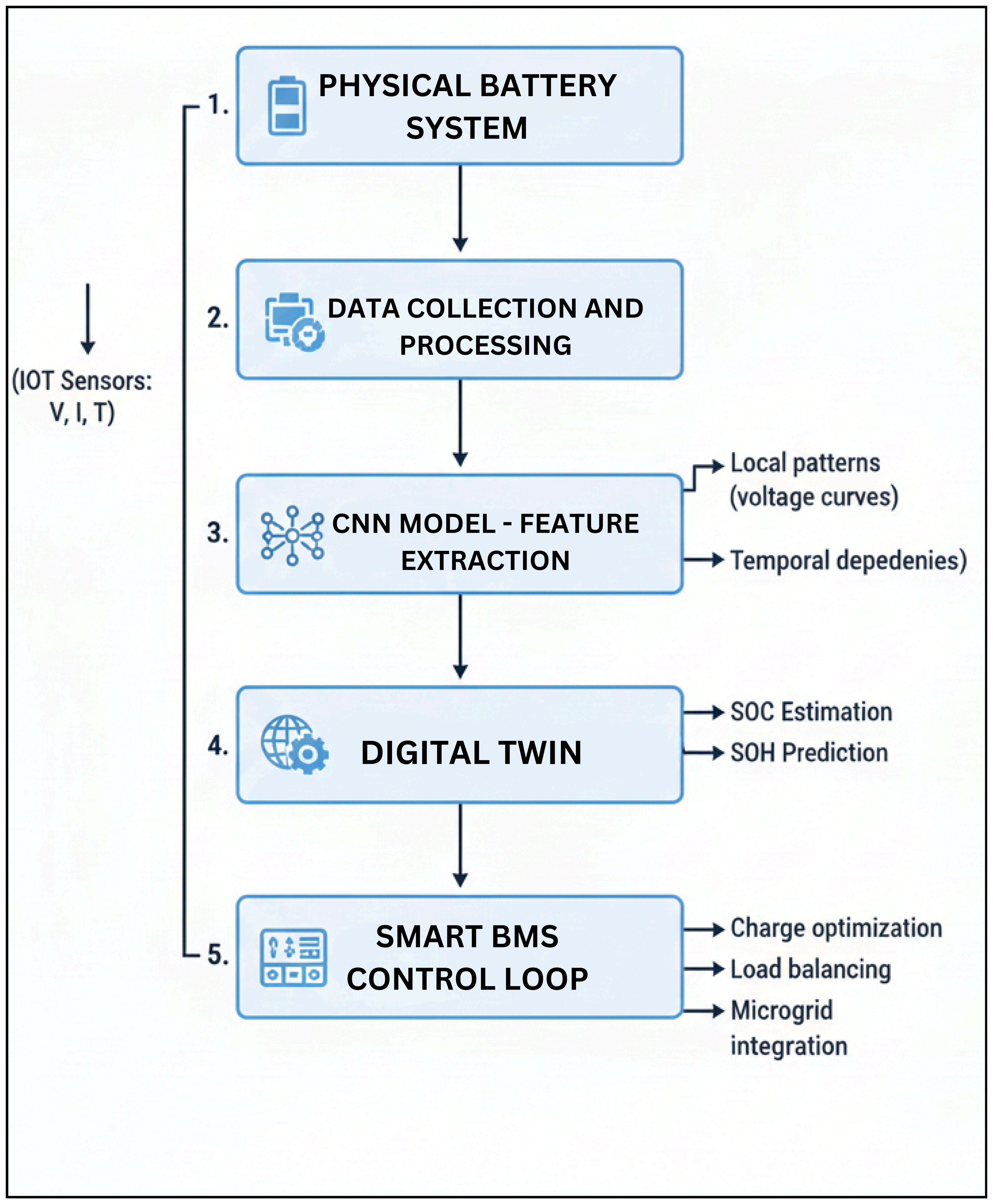

Fig 1. *CNN-Driven Digital Twin Architecture for Predictive Battery Energy Storage System Control.*

RESULTS

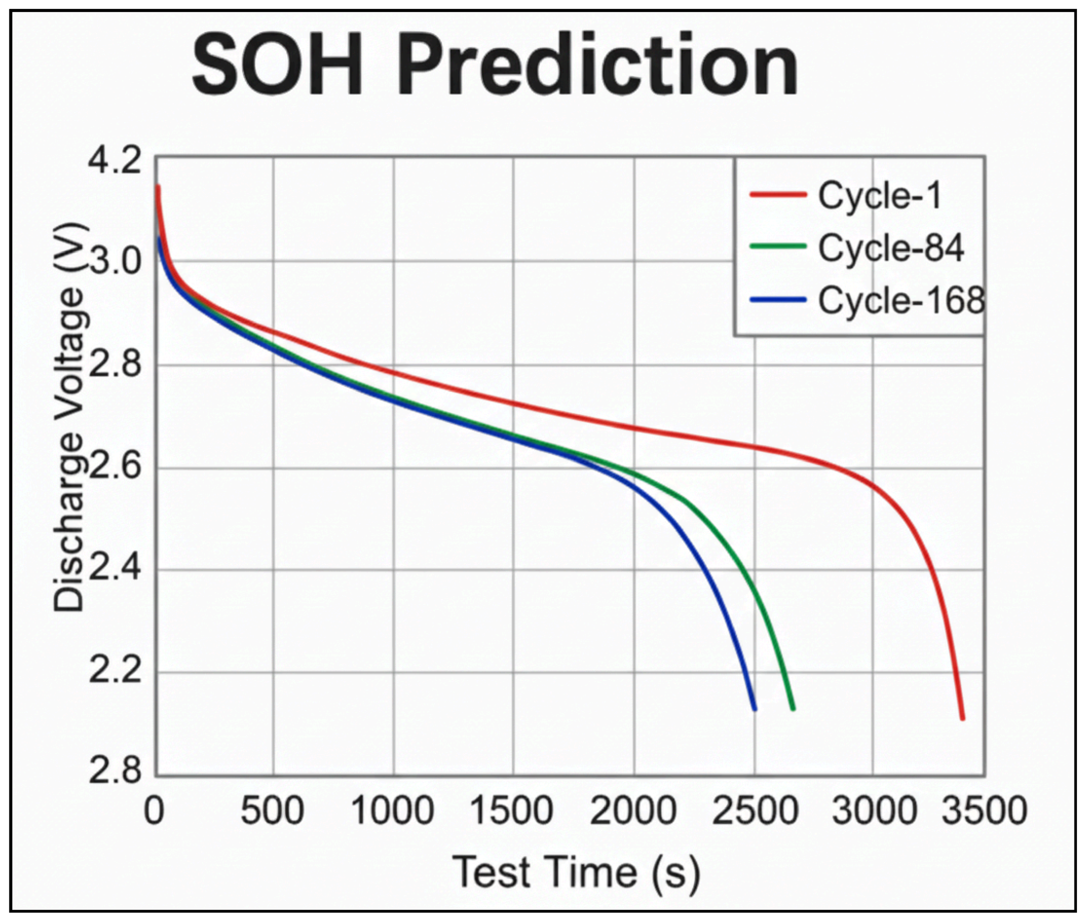

Fig 2. *Battery digital twin visualization integrating real-time health indicators with SOH*

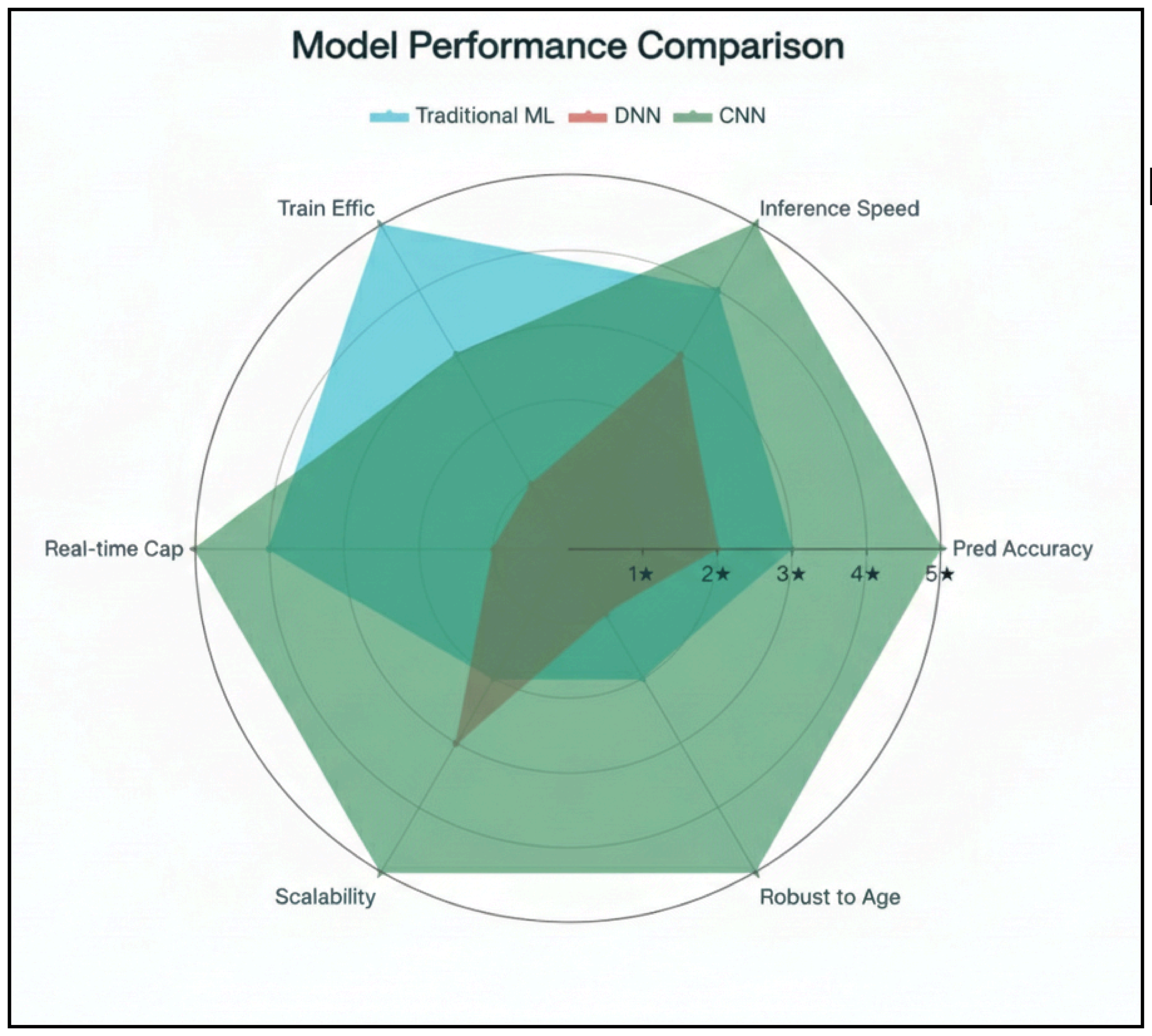

Fig 3. *Radar chart comparing CNN, DNN, and traditional machine learning models across key battery management performance metrics. CNN exhibits superior ratings in accuracy, speed, real-time operations, scalability, and robustness.*

CONCLUSION & RECOMMENDATION

- AI-powered CNN digital twins provide highly accurate and reliable battery SOC and SOH estimations, leading to enhanced energy management, longer battery life, and improved microgrid stability.
- Incorporating dynamic battery aging and environmental conditions into CNN models will increase robustness and prediction adaptability across diverse operational scenarios.
- Deploying optimized, lightweight CNN models on edge computing platforms is recommended to enable real-time, efficient battery monitoring and autonomous control with minimal computational overhead.

REFERENCES

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