Journal of Intelligent Pervasive and Soft Computing

journal homepage: https://journals.aipspub.com/index.php/jipsc/

Mini-Review

An IoT Blockchain Network-Based Approach for Optimizing Smart Contracts in Electric Vehicles for Environmental Control

Harun Jamil [1]

[1]Department of Electronic Engineering, Jeju National University, Jeju-si, Jeju-do, Republic of Korea, 63243.
*Correspondence: harunjamil@hotmail.com;

Abstract

This study proposes a smart contract model for optimizing energy management in electric vehicles based on IoT blockchain networks. The model consists of three hierarchical layers: prediction, optimization, and control. In the prediction layer, a Kalman filter is used to remove noise and extract environmental features. The optimization layer utilizes the BAT algorithm to optimize energy consumption and user comfort, incorporating user preferences into the comfort index formula. A convolutional fuzzy logic controller is integrated with the prediction module to enhance performance. The control module tunes membership functions dynamically to improve control performance. The Hyperledger Fabric network is employed for evaluating the proposed model, considering metrics such as caliper, latency, throughput, and resource utilization. This research aims to address challenges related to energy management trade-offs, data privacy, security, and cost in IoT-based systems for electric vehicles.

Keywords: *Energy management; Blockchain network; Resource utilization; Electric vehicles; IoT;*

Introduction

In recent years, the comfort of passengers in electric vehicles has gained significant attention, aiming to provide a solution that balances comfort and energy efficiency [1]. This study focuses on optimizing the trade-off between energy consumption and occupant comfort by considering HVAC parameters and employing AI-based optimization and control methods [2]. By addressing high energy consumption through alternative sources and resource efficiency, the proposed model integrates a prediction module using the Kalman filter, an optimization module based on the Bat Algorithm and user preferences learning, and a control module utilizing a fuzzy inference controller [3]. The objectives are to reduce energy consumption, enhance optimization and control, and dynamically adjust user comfort preferences [4].

Recent research has explored the use of machine learning for prediction in various applications, including electric vehicles. Deep learning, fuzzy inference, artificial neural networks (ANN), and Kalman filter-based approaches have been utilized for energy consumption prediction in residential areas and smart homes [5]. Optimization techniques such as particle swarm optimization (PSO) and the bat algorithm have been employed to improve prediction model performance [6]. Evolutionary approaches, fuzzy logic controllers, and bee colony methods have been utilized for energy consumption optimization [7]. Modifications to traditional fuzzy logic controllers have been proposed, including integration with ANN models. These approaches have been applied to control parameters such as power distribution, IP cameras, and thermal comfort in electric vehicles and residential buildings [8]. This work presents a novel approach that combines prediction, optimization, and control algorithms, with enhancements achieved through learning modules.

Related Work

Several research studies have explored the integration of AI-based techniques for energy management and occupant comfort in various applications, including electric vehicles and smart homes. Deep learning, fuzzy inference, artificial neural networks (ANN), and Kalman filter-based approaches have been utilized for energy consumption prediction in residential areas and smart homes [9]. Optimization techniques such as particle swarm optimization (PSO) and the bat algorithm have been employed to improve prediction model performance [10]. Evolutionary approaches, fuzzy logic controllers, and bee colony methods have been utilized for energy consumption optimization [11]. Furthermore, some studies have proposed modifications to traditional fuzzy logic controllers, integrating them with ANN models to control parameters such as power distribution, IP cameras, and thermal comfort in electric vehicles and residential buildings [12]. However, these prior works have primarily focused on individual aspects of energy management and comfort optimization, lacking an integrated approach.

Proposed Methodology

This research proposes an innovative approach that combines optimization and control to address energy consumption and user comfort. Figure.1, shows the four main components: prediction (using the Kalman

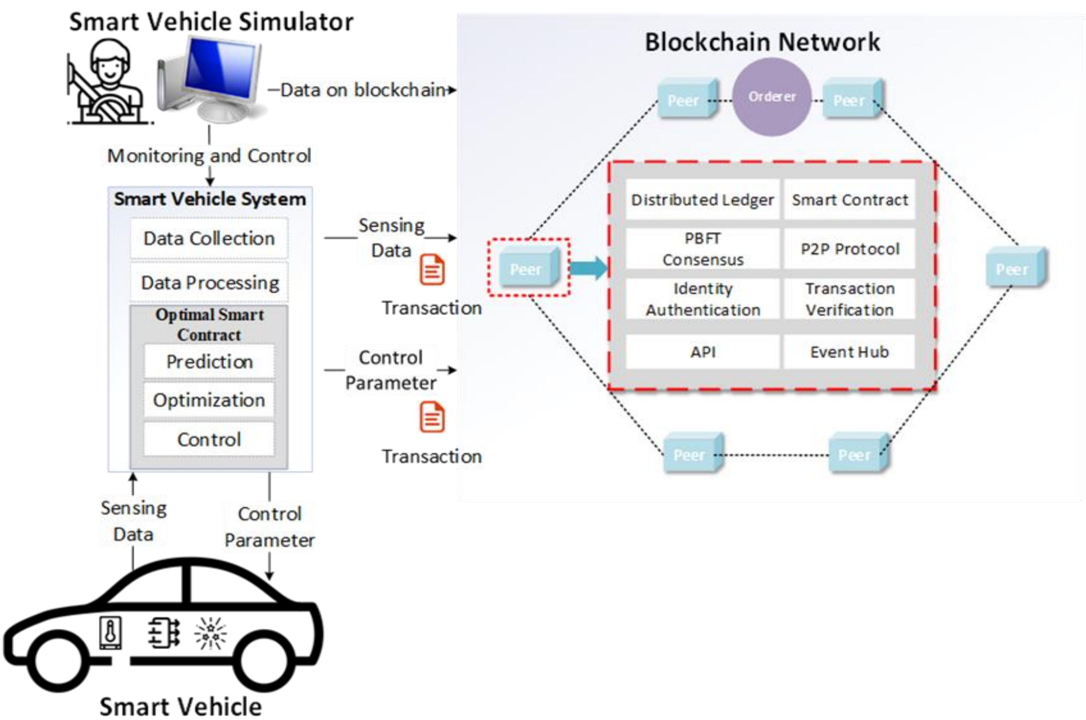

Fig. 1. Proposed platform-based Optimization for Efficient Operational Controls in Electric Vehicles Environment.

filter for accurate parameter estimation), optimization (applying the bat optimization algorithm), control (utilizing a fuzzy inference control module), and a blockchain-based security module. The blockchain network securely stores sensor data and actuator information.

The methodology comprises four main components, as illustrated in Figure 1. Prediction using the Kalman Filter: The first component involves prediction, where the Kalman filter is employed for accurate parameter estimation. The Kalman filter is a recursive algorithm that helps remove noise from sensor measurements and provides more precise predictions of environmental features related to energy consumption and occupant comfort. Optimization using the Bat Optimization Algorithm: The second component focuses on optimization, where the bat optimization algorithm is utilized. The bat optimization algorithm is a nature-inspired metaheuristic optimization technique that simulates the behavior of bats to search for optimal solutions. In the context of the paper, the algorithm is applied to optimize energy consumption while considering user comfort preferences as part of the optimization criteria. Control using a Fuzzy Inference Control Module: The third component involves control, which utilizes a fuzzy inference control module. Fuzzy logic is a computing approach that deals with uncertainty and imprecise information. The fuzzy inference control module is designed to enhance control performance, ensuring that energy management decisions align with the optimization results while taking into account real-time environmental conditions and user preferences.

Blockchain-Based Security Module: The fourth component is a blockchain-based security module. The proposed approach leverages a blockchain network to securely store sensor data and actuator information. By using blockchain, data integrity, transparency, and immutability are ensured, making it suitable for maintaining a reliable and tamper-proof record of sensor data and control actions. Figure 1 likely depicts the interconnectedness of these four components, showcasing how data flows between prediction, optimization, and control modules, while the blockchain network ensures the security and privacy of data and control commands. By combining these components, the proposed methodology aims to achieve an integrated approach to energy management in electric vehicles, optimizing energy consumption while providing a comfortable and environmentally controlled experience for the vehicle occupants.

Experimental Results

In this section, Figure 2 depicts the original values, sensing values, and the predicted values for temperature obtained through the Kalman filter. The results indicate that the predicted values are closer to the original values compared to the sensing values. Therefore, the predicted values have been selected for subsequent processing.

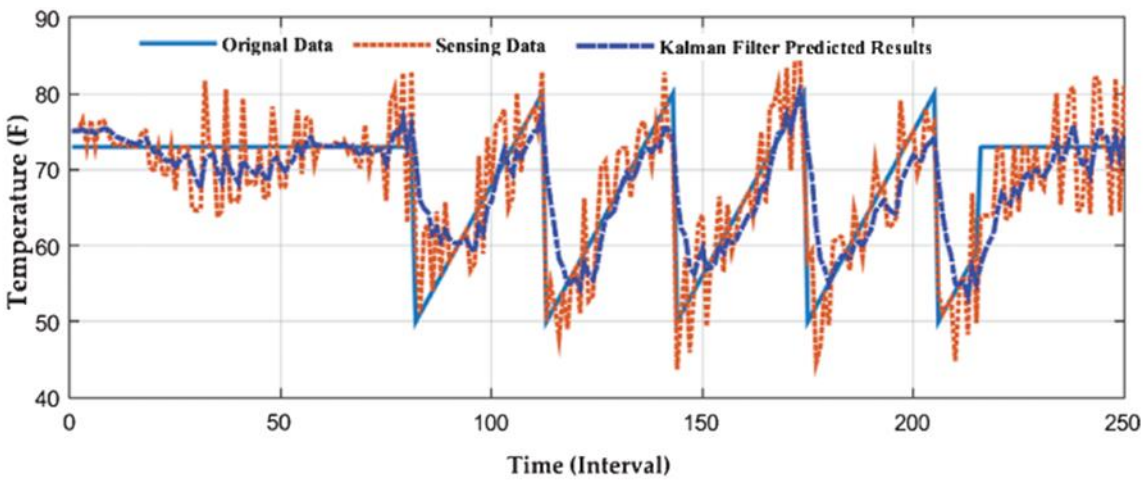

Fig. 2. Real-time sensors assisting in accelerated drug screening.

Conclusion

The proposed model utilizes the Kalman filter for prediction, the bat algorithm for optimization, and a fuzzy inference controller for control. The main objectives are to reduce energy consumption, maximize user comfort, and enhance optimization and control performance. The model allows dynamic adjustment of user comfort through machine learning algorithms. By tuning membership functions using a machine learning approach, the performance of the Mamdani fuzzy logic controller is improved. The proposed model maintains a high user comfort index while minimizing power consumption. Future research will consider additional environmental parameters and explore alternative optimization algorithms and control approaches, such as PID and Sageno fuzzy logic.

References

[1] H. Jamil, F. Qayyum, N. Iqbal, and D.-H. Kim, 'Enhanced Harmonics Reactive Power Control Strategy Based on Multilevel Inverter Using ML-FFNN for Dynamic Power Load Management in Microgrid', Sensors, vol. 22, no. 17, Art. no. 17, Jan. 2022, doi: 10.3390/s22176402.

[2] F. Qayyum, H. Jamil, F. Jamil, S. Ahmad, and D.-H. Kim, 'IoT-Orchestration based nanogrid energy management system and optimal time-aware scheduling for efficient energy usage in nanogrid', International Journal of Electrical Power & Energy Systems, vol. 142, p. 108292, 2022.

[3] F. Qayyum, H. Jamil, F. Jamil, and D. Kim, 'Predictive Optimization Based Energy Cost Minimization and Energy Sharing Mechanism for Peer-to-Peer Nanogrid Network', IEEE Access, vol. 10, pp. 23593–23604, 2022, doi: 10.1109/ACCESS.2022.3153837.

[4] F. Jamil, N. Iqbal, Imran, S. Ahmad, and D. Kim, 'Peer-to-Peer Energy Trading Mechanism Based on Blockchain and Machine Learning for Sustainable Electrical Power Supply in Smart Grid', IEEE Access, vol. 9, pp. 39193–39217, 2021, doi: 10.1109/ACCESS.2021.3060457.

[5] H. Jamil, F. Qayyum, N. Iqbal, F. Jamil, and D. H. Kim, 'Optimal Ensemble Scheme for Human Activity Recognition and Floor Detection Based on AutoML and Weighted Soft Voting Using Smartphone Sensors', IEEE Sensors Journal, vol. 23, no. 3, pp. 2878–2890, Feb. 2023, doi: 10.1109/JSEN.2022.3228120.

[6] F. Jamil, S. Ahmad, T. K. Whangbo, A. Muthanna, and D.-H. Kim, 'Improving blockchain performance in clinical trials using intelligent optimal transaction traffic control mechanism in smart healthcare applications', Computers & Industrial Engineering, vol. 170, p. 108327, Aug. 2022, doi: 10.1016/j.cie.2022.108327.

[7] S. Sieniutycz and J. Jezowski, Energy Optimization in Process Systems. Elsevier, 2009.

[8] 'Energy Performance of Residential Buildings - Google Books'. https://www.google.co.kr/books/edition/Energy_Performance_of_Residential_Buildi/zS2PF6A7n7QC?hl=en&gbpv=1&dq=residential+buildings&printsec=frontcover (accessed Jul. 13, 2023).

[9] Kumar, A., Alaraj, M., Rizwan, M., & Nangia, U. (2021). Novel AI based energy management system for smart grid with RES integration. *IEEE Access*, *9*, 162530-162542.

[10] Das, D., Pratihar, D. K., Roy, G. G., & Pal, A. R. (2018). Phenomenological model-based study on electron beam welding process, and input-output modeling using neural networks trained by back-

propagation algorithm, genetic algorithms, particle swarm optimization algorithm and bat algorithm. *Applied Intelligence*, *48*, 2698-2718.

[11] Castillo, O., & Amador-Angulo, L. (2018). A generalized type-2 fuzzy logic approach for dynamic parameter adaptation in bee colony optimization applied to fuzzy controller design. Information Sciences, 460, 476-496..

[12] Royapoor, M., Antony, A., & Roskilly, T. (2018). A review of building climate and plant controls, and a survey of industry perspectives. *Energy and Buildings*, *158*, 453-465.