

Abstract

The digital transformation of healthcare has increased the demand for analytical frameworks that can securely process the data. These frameworks address the rapidly growing volumes of medical data generated across interconnected hospitals and Internet of Medical Things (IoMT) ecosystems. Recent progress in distributed and privacy-preserving learning has reduced dependence on centralized storage of data. Most existing approaches are centralized in terms of model optimization. They pay little attention to underlying distributed data management issues in multi-institution healthcare environments. However, limited coordination between distributed healthcare data repositories often leads towards inconsistency, reduced reliability, and scalability. The final result negatively affects the reliability and scalability of collaborative healthcare analytics. In an effort to close this structural gap, the current study proposed the Federated Distributed Database System (FedDDBS). It is a coordinately designed hierarchical architecture consisting of robust database coordination as well as federated intelligence. The proposed approach enables healthcare institutions to perform local model training on protected medical data. It also ensures continuity and security of distributed data storage. Moreover, it deploys a pipeline of validation stages with multi-stage verification. Afterwards, it combines these verified updates. Experimental results proved that integrating the concepts of the DDBMS and Federated Learning (FL) enhanced data integrity and strengthened communication security. It also stabilized the model convergence without violating strict privacy provisions. In general, FedDDBS offers a scalable, high-assurance system for healthcare analytics. It delivers trustworthy intelligence within various medical facilities under the condition of adherence to privacy-preserving standards.

Index Terms: Distributed databases, fog computing, Federated Learning (FL), healthcare, Internet of Medical Things (IoMT)