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(57) Abstract :

The present invention discloses a hardware-integrated explainable artificial intelligence system (100) comprising a multi-processor computing architecture (101), a sensor data acquisition module (102), a causal inference engine (103), an attribution computation unit (104), and a certification module (105). The system addresses opacity in machine learning models by implementing gradient-based SHapley Additive exPlanations through dedicated hardware accelerators (106) operating on latent space representations generated by variational autoencoders (107). A causal decomposition processor (108) performs synergistic, unique, and redundant decomposition of feature contributions, enabling identification of physical mechanisms from high-dimensional data. The invention provides technical effects including reduced computational latency, improved memory utilization, and enhanced processing throughput for real-time explainability in scientific discovery, engineering optimization, and regulatory certification applications across fluid dynamics, aerospace, healthcare, and autonomous systems industries.

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