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(57) Abstract :

The present invention relates to a hardware-accelerated optimization system (100) comprising a processor unit (101), memory architecture (102), automatic differentiation engine (103), and duality computation module (104) for solving large-scale cone programming problems. The system integrates differentiable programming with Fenchel-Rockafellar duality theory and first-order methods including Alternating Direction Method of Multipliers and Primal-Dual Hybrid Gradient algorithms executed on GPU-accelerated tensor processing units (105). A computational graph constructor (106) builds directed acyclic graph representations enabling reverse-mode automatic differentiation for gradient computation. The primal-dual solver module (107) simultaneously updates primal and dual variables through projected gradient operations with adaptive step-size selection. The system achieves convergence acceleration through hardware-optimized matrix-vector operations, achieving measurable improvements in processing latency and solution quality for industrial optimization applications including power systems, neural network verification, and signal processing.

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