पेटेंट कार्यालय
शासकीय जर्नल

OFFICIAL JOURNAL
OF
THE PATENT OFFICE

निर्गमन सं. 20/2026	शुक्रवार	दिनांक: 15/05/2026
ISSUE NO. 20/2026	FRIDAY	DATE: 15/05/2026

पेटेंट कार्यालय का एक प्रकाशन
PUBLICATION OF THE PATENT OFFICE

(12) PATENT APPLICATION PUBLICATION

(19) INDIA

(22) Date of filing of Application :02/04/2026

(21) Application No.202611042565 A

(43) Publication Date : 15/05/2026

(54) Title of the invention : A SYSTEM AND METHOD FOR MASS-PRESERVING NEURAL DECODING IN MANIFOLD-BASED DATA RECONSTRUCTION

(51) International classification	:G06N 3/04, G06N 3/08, G06N 3/063, G06F 17/16, G06F 17/14
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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(57) Abstract :
The present invention relates to a hardware-implemented neural decoder system (100) for mass-preserving reconstruction of high-dimensional data from low-dimensional manifold embeddings. The system comprises a processing module (101) with dedicated processor (102) and non-transitory memory (103), a feature generation unit (104) implementing random Fourier feature transformations with hierarchical multi-scale sampling architecture (105), and a constrained optimization engine (106) employing Lagrange multiplier formulation stored in optimization memory (107). The decoder receives encoded latent coordinates through input interface (108), processes them through feature matrix computation unit (109) incorporating output bias column ensuring sum-to-one invariant membership in feature column space, and generates reconstructed high-dimensional outputs via output interface (110). The closed-form solution module (111) computes coefficient matrices through singular value decomposition unit (112) achieving mass conservation at machine precision without iterative soft-constraint penalties. The invention finds industrial application in traffic flow prediction systems, medical imaging reconstruction platforms, and crowd dynamics monitoring apparatus.

No. of Pages : 21 No. of Claims : 10