Chikan Old Street Industrial Upgrading: The STGNN-ISM Solution

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Introduction or abstract

Chikan Old Street, a 1.2 km² historic core in Zhanjiang, still relies on manual experience for industry-space matching, causing low green-area usage (35 %) and stagnant revenue. We propose STGNN-ISM, the first spatio-temporal graph neural network that embeds “spatial-gene” features (architecture, greenery, cultural activity) with multi-industry flows.Trained on 247 k field records (2023), it delivers real-time resource-allocation decisions in ≤ 90 ms.

Objectives

1. Quantify the three tech dimensions of industrial-function digitalisation.
2. Build STGNN-ISM to dynamically match spatial genes with tourism, creative & retail nodes.
3. Validate ≥ 15 % revenue uplift and ≥ 75 % space-utilisation on site.

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Results

Matching accuracy: 89.2 % (test) ↑18.7 pp vs LSTM.
Latency: 42 ms single / 89 ms batch (≤ 100 ms real-time).
Revenue lift: cultural-tourism +23.5 %, creative +19.2 %, homestay +15.8 %; overall +19.5 %.
Green-area utilisation: 35 % → 78 %; surrounding creative shops sales +28.5 %.
Robustness: –5.3 % accuracy under 20 % Gaussian noise.

Conlcusion

STGNN-ISM converts “space-industry” coupling into a learnable graph, providing an end-to-end, low-latency decision engine for historic districts. It simultaneously boosts heritage protection, green-quality targets (“Green & Beautiful Zhanjiang”) and business revenue, offering a replicable path for digital regeneration of old streets.

Materials & Methods

- 240 spatial nodes (50 m grid) × 4 industry types = 1 440 graph nodes.
- Spatial-gene vector 128-D (α=0.4 heritage, 0.3 green, 0.3 culture).
- Industry vector 48-D flow + 7-D sales + Occ-rate; edge weight λ=0.4.
- Temporal attention window T = 7 days; GATConv 64-D embedding.
- Multi-objective loss: 40 % space-util error + 50 % revenue error + 10 % L2.
- Hardware: RTX-4090, PyTorch 2.1; data split 7:2:1.

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