Robust Mathematical Symbol Recognition via Metric-Based Template Matching

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① The Study

🧩 **Problem:** Converting math images to LaTeX is hard due to 2D structure, fragmented symbols, and large character sets. Classical CCA fails when strokes break (e.g., ∫) or multi-part glyphs separate (e.g. i, ÷, ≈).

⚙️ **Solution:** An *Adaptive Recursive Clustering* framework that re-groups components using recognition-driven feedback instead of static segmentation.

📐 **Core Theory:** Similarity is evaluated in a normalized metric space using *L2*, *Hausdorff*, and *Chamfer* measures.

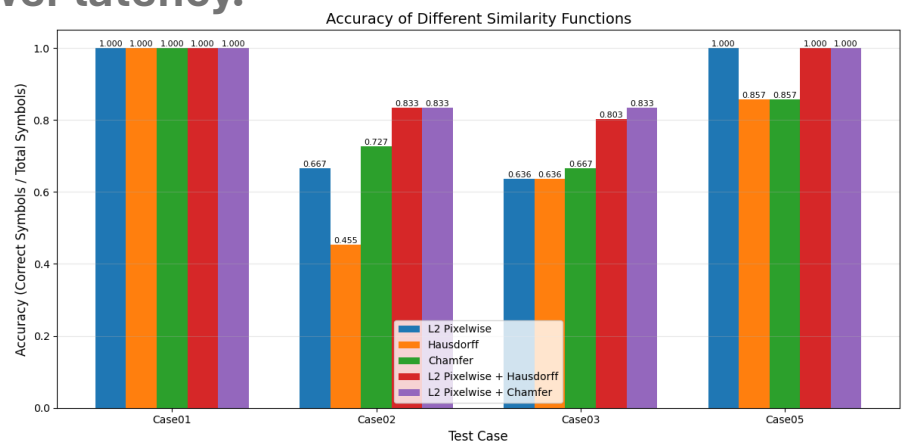
📚 **Gap:** Little research compares these metrics inside a recursive clustering loop.

🎯 **Objective:** Identify which metric best guides reconstruction of fragmented math symbols, with the hypothesis that *Chamfer* is most robust.

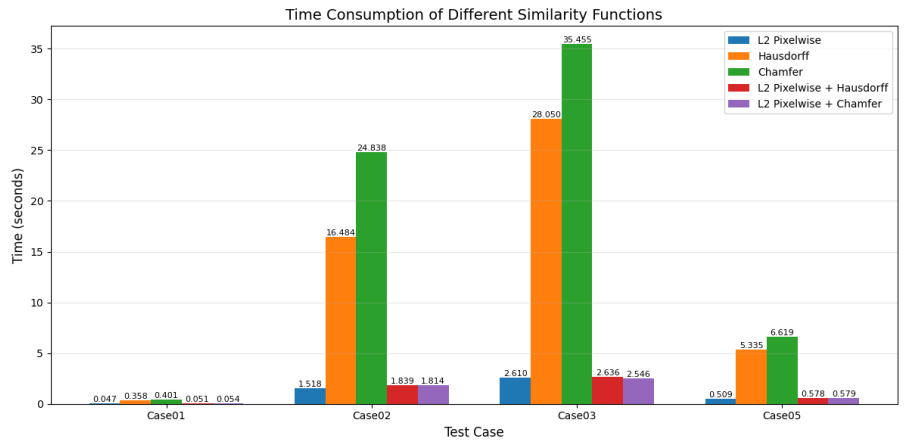
⚠️ **Key limitation:** Sensitive to poor image quality, rotation, and noise, and template matching does not scale efficiently to larger symbol libraries without advanced indexing.

② Findings

Hybrid metrics yield the best trade-off: L2 filters quickly, Chamfer handles fragmentation, and together they deliver higher accuracy with far lower latency.



L2 + Chamfer achieves the highest accuracy



Hybrid metrics cut computation time by using L2 as a fast pre-filter

③ Research in context

Before this study

Rule-based Math-OCR lacked reliable handling of fragmented symbols and had no metric-level performance comparison.

Added value

We benchmarked L2, Hausdorff, and Chamfer inside an adaptive clustering pipeline across desktop and mobile hardware.

Implications

Hybrid metrics—especially L2 + Chamfer—offer accurate, light-weight, and mobile-feasible recognition of complex math symbols.