Ahmedabad University

ECE501- Digital Image Processing

Content-Based Image Retrieval (CBIR)

Group 6

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Introduction

- Due to an exponential increase of image data across every domain, there is a need of systems that retrieve images based on the actual **visual characteristics** (extracting features) to get *meaningful searches*.

- **Objective:** To implement a CBIR system for a diverse dataset and retrieve similar images based on traditional methods using features like colour, texture, shape and similarity metrics.

- **Summary** of work done before Mid-Sem:

  - The dataset was extremely varied as it consisted of 10 different domains.
  - Every feature was **computed individually** for extraction, like only edge or only colour or only feature fusion and then implemented for the dataset.
  - The methods we had used were HSV, LBP, Sobel and Euclidean distance for retrieval.
  - We didn't work much on the accuracy and comparisons of the results obtained.

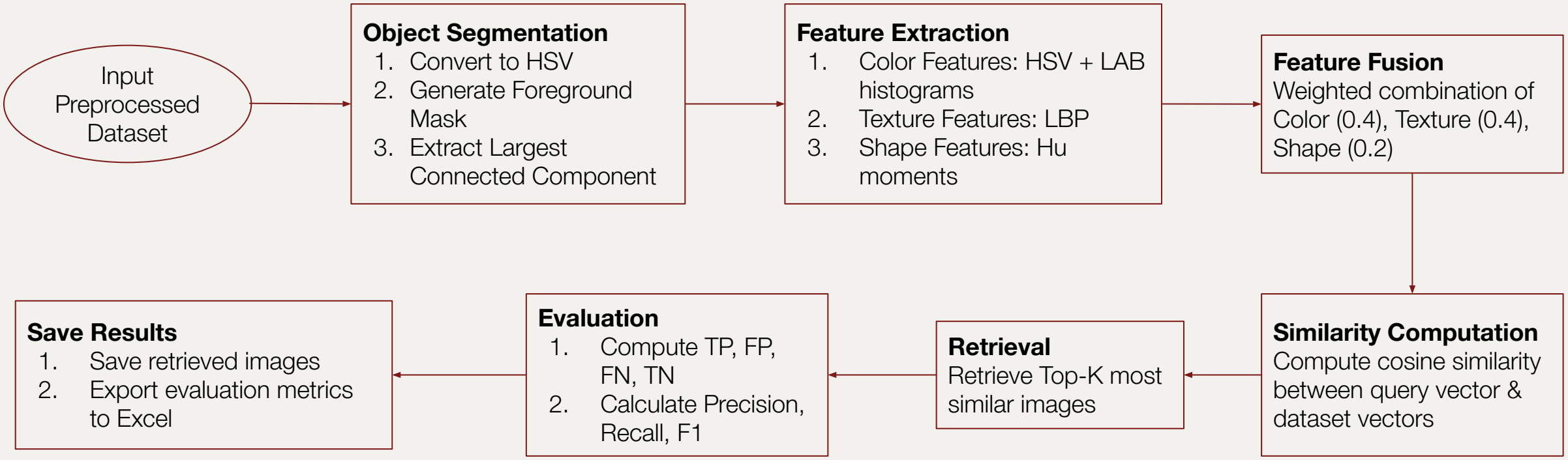
Outcomes and takeaways from initial work

- The individual feature extraction was not adaptable after a certain extent as the results were inconsistent.
- Its performance was domain-specific; it gave meaningful results only for few. Thus, 10 domains were too broad for this system.
- Colour feature was dominant in giving wrong results for gray-scale images.

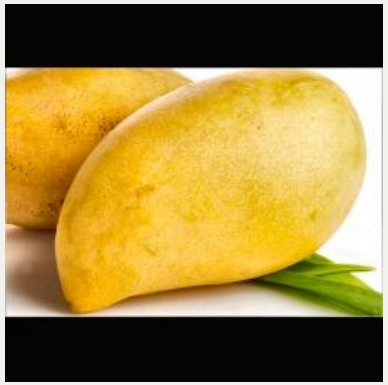
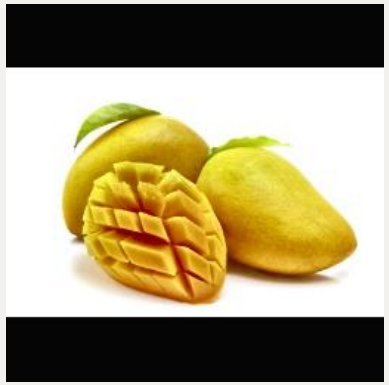
- Improved Implementations Based on the Conclusions:
  - To improve the consistency, analyze performance and compare meaningfully, we kept three main domains: Brain MRI Scans, Natural, Paintings
  - By experimenting through trial and error we selected weights such that it balances the contribution of features during retrieval.
  - We numerically compared our results using standard evaluation metrics like recall, precision and F1-score.

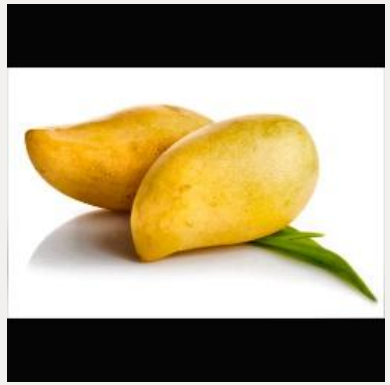
Updated Methodology

The following flowchart shows the method:

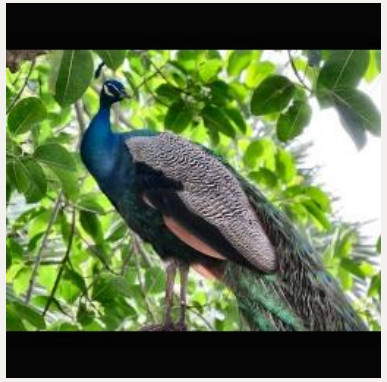


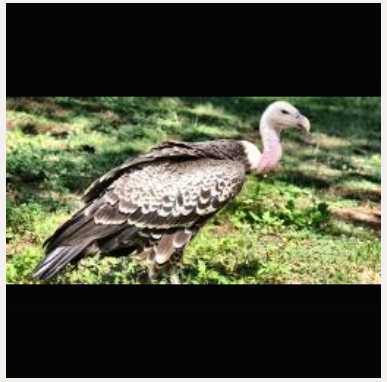
Results (Domain - Natural)



Query | Rank 1 | Rank 2 | Rank 3 | Rank 4 | Rank 5






Results (Domain - Paintings)


Query


Rank 1


Rank 2


Rank 3


Rank 4


Rank 5

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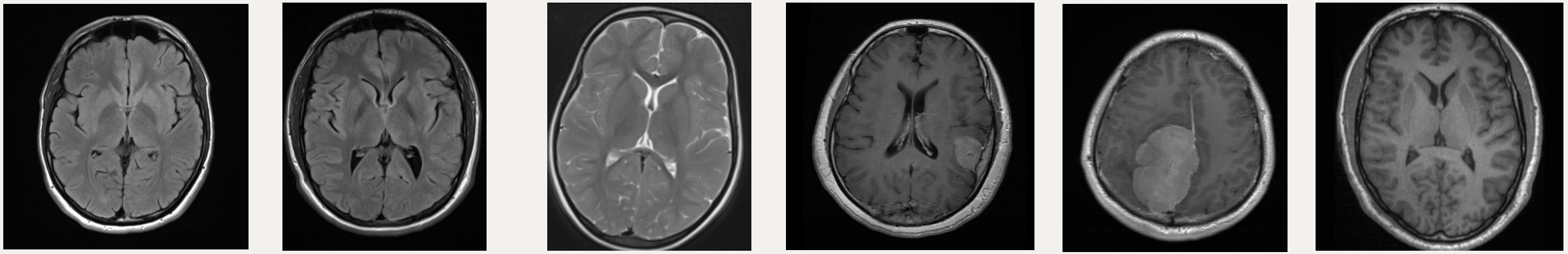
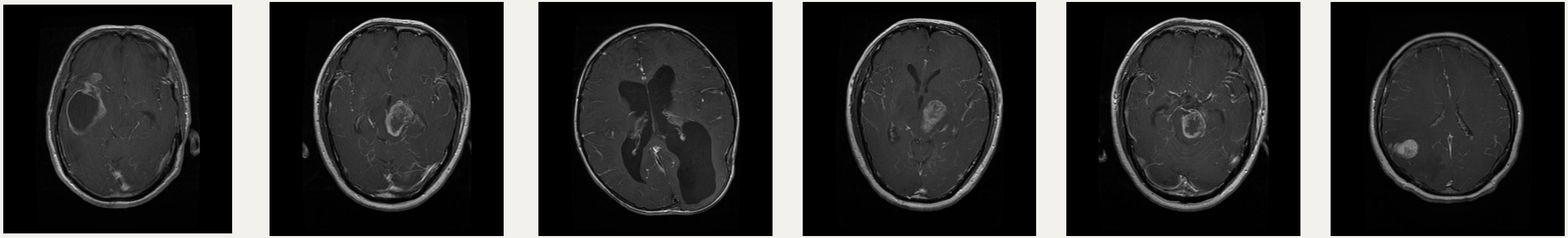
Results (Domain - Brain MRI)

Glioma



Query | Rank 1 | Rank 2 | Rank 3 | Rank 4 | Rank 5



No Cancer **Meningioma**

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Result - Evaluation Metrics

Methods	Precision	Recall	F1 score
Color Extraction	0.74	0.27	0.35
Texture Extraction	0.48	0.12	0.12
Concatenation	0.44	0.12	0.16
Weighted Fusion	0.80	0.30	0.39

Optimal Weights for Different Domains

Domains	Color	Texture	Shape	Precision
Natural	0.4	0.4	0.2	0.76
Brain MRI	0.1	0.6	0.3	0.77
Paintings	0.3	0.3	0.4	0.85

Conclusions

- Content Based Image Retrieval system retrieving similar images across three domains: Natural, Paintings and Brain MRI.
- Extracted multiple visual features like color, texture and shape using weights to enhance retrieval performance.
- No single feature performs best for all domains.
- For MRI scans, system effectively detecting and matching cancer affected areas.
- Successfully implemented an integrated pipeline including preprocessing, feature extraction, similarity computation and ranking.

References

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Dataset - References

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