# MULTIMODEL MEDICAL IMAGE FUSION FOR IMPROVED DIAGNOSIS USING SHEARLET TRANSFORM AND SVD

Pydimarri Padmaja[1]*,Theegala JagruthiZ,Yadavalli Rajeswari[3],Ranga pallavi[4],Yesu Chandu[5]

[1]Associate Professor, [2]–[5]Students, Dept. of ECE, Teegala Krishna Reddy Engineering College, Telangana, India - 500097

*Corresponding author: padmajavattem@gmail.com

## ABSTRACT

This study presents a two-stage medical image fusion framework that integrates the Shearlet Transform and Singular Value Decomposition (SVD) to enhance multimodal medical image analysis. The Shearlet Transform is employed to decompose input images MRI into multi-scale and multi-directional subbands, effectively capturing structural and textural features. Corresponding subbands are fused using SVD by combining their singular values through a rule-based strategy. The fused subbands are reconstructed using the inverse Shearlet Transform to generate a high-quality image that preserves complementary anatomical and functional information, supporting improved tumor visualization and clinical decision-making**.**

**Keywords :** Medical Image Fusion, Shearlet Transform, Singular Value Decomposition, Multimodal Medical Imaging, MRI-CT-PET Fusion, Tumor Visualization, Feature Extraction, Clinical Decision Support.

## 1. INTRODUCTION

Multimodal medical imaging plays a vital role in accurate diagnosis by integrating complementary information from MRI, CT, and PET images. Since each modality provides unique anatomical and functional insights, analyzing them separately may limit clinical interpretation, especially in tumor assessment. Therefore, effective medical image fusion is essential to enhance diagnostic performance. This paper proposes a two-stage multimodal image fusion framework using the Shearlet Transform and Singular Value Decomposition (SVD). The Shearlet Transform decomposes input images into multi-scale and multi-directional subbands, while SVD-based fusion combines significant features from each modality. The fused image preserves both structural and functional information, leading to improved tumor visualization and better clinical decision support.

## 2. METHODOLOGY

The proposed multimodal medical image fusion framework follows a two-stage approach that integrates the Shearlet Transform and Singular Value Decomposition (SVD) to effectively combine complementary information from medical imaging modalities such as MRI, CT, and PET. In the first stage, the registered multimodal input images are decomposed using the Shearlet Transform, which provides a multi-scale and multi-directional representation for efficient extraction of structural, textural, and edge features, resulting in corresponding low- and high-frequency subbands that capture both coarse and fine image details. In the second stage, fusion is performed on the corresponding Shearlet subbands using Singular Value Decomposition, where each subband is decomposed into singular components and a rule-based strategy is applied to

combine dominant singular values from different modalities, ensuring preservation of significant anatomical and functional features while minimizing redundancy. Finally, the fused subbands are reconstructed using the inverse Shearlet Transform to obtain the final fused image, which retains enhanced structural clarity and functional information, thereby improving tumor visualization and supporting accurate clinical decision-making.
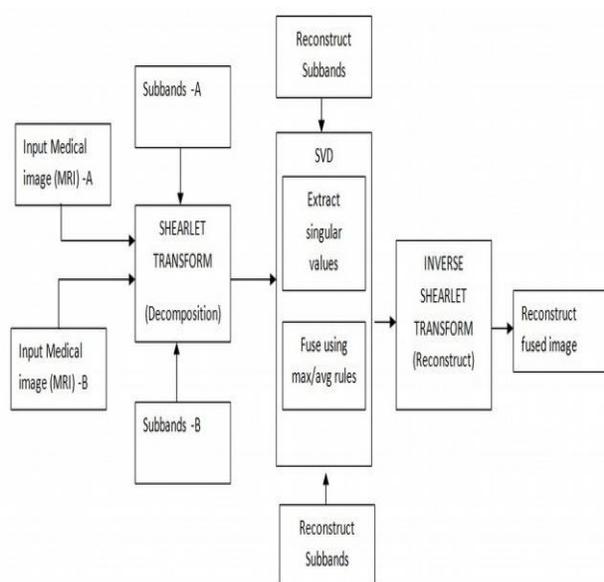
## 3. BLOCK DIAGRAM



Fig. 1 Block Diagram

The proposed fusion framework begins with two registered medical images obtained from different modalities, which are first subjected to Shearlet Transform–based decomposition. This transform decomposes each input image into multi-scale andmulti-directional subbands, enabling effective representation of edge, texture, and structural information. Corresponding subbands from each modality are then processed using Singular Value Decomposition (SVD), where significant singular values are extracted and fused using rule-based

strategies such as maximum or average selection to retain dominant features. The fused singular components are used to reconstruct the corresponding subbands, ensuring preservation of complementary anatomical and functional information. Finally, the inverse Shearlet Transform is applied to the fused subbands to generate the final fused image, which exhibits enhanced structural clarity and improved visualization, supporting accurate tumor analysis and clinical interpretation.

## 4. PROPOSED SYSTEM

The proposed system employs a multimodal medical image fusion framework using the Shearlet Transform and Singular Value Decomposition (SVD). Input medical images are decomposed into multi- scale and multi-directional subbands using the Shearlet Transform. Corresponding subbands are fused through an SVD-based rule to preserve dominant anatomical and functional features. The fused subbands are reconstructed using the inverse Shearlet Transform to obtain a high-quality fused image that enhances tumor visualization and supports accurate clinical analysis.
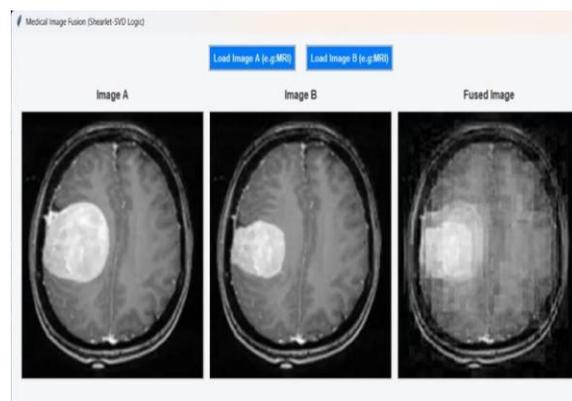
## 5. OUTPUT



Fig. 2 resulting Fused Image

The fusion results obtained from the proposed Shearlet Transform and SVD-based framework, showing the input medical images (Image A and Image B) along with the resulting fused image. The fused image effectively preserves complementary anatomical details and enhances tumor visibility, demonstrating the effectiveness of the proposed fusion approach.



Fig.3 Fusion performance metrices

## 6. CONCLUSION

This work presented an effective multimodal medical image fusion framework that combines the Shearlet Transform with Singular Value Decomposition to integrate complementary information from medical imaging modalities. The multi-scale and multi-directional properties of the Shearlet Transform enable accurate extraction of structural features, while the SVD-based fusion strategy preserves dominant anatomical and functional information. Experimental results demonstrate that the proposed approach produces high-quality fused images with enhanced clarity and improved tumor visualization. The quantitative evaluation further confirms the robustness and effectiveness of the method. Overall, the proposed framework shows strong potential for supporting reliable clinical analysis and advancing multimodal medical image interpretation.

## 7. REFERENCES

1. Biswas, N., Ghoshal, S. "Medical image fusion by combining SVD and shearlet transform." Procedia Computer Science, vol. 167, pp. 1725–1732, 2020.

2. Sharma, R., Babu, T. S., Hafiz, A., et al. "Two stage multi-modal medical image fusion with marine predators optimization algorithm." Expert Systems with Applications, vol. 232, 2023.

3. Yang, Y., et al. "Medical Image Fusion Based on Fast Finite Shearlet Transform." BioMed Research International, vol. 2019, Article ID 6421746, 2019.

4. Qiu, T., Yan, Z., et al. "Multi-modality medical image fusion based on non-subsampled shearlet transform and sum-modified Laplacian." Computer Methods and Programs in Biomedicine, vol. 156, pp. 209–222, 2018.

5. Zhang, X., Li, K., et al. "A Review of Multimodal Medical Image Fusion Techniques." Computational Intelligence and Neuroscience, vol. 2020, Article ID 8279342, 2020.

6. Bhowmik, R., et al. "Multimodality Medical Image Fusion Using Clustered Dictionary and non-subsampled Shearlet Transform." Scientific Reports, vol. 13, Article 10137354, 2023.

7. Tiwari, A., et al. "Optimal feature selection for medical image fusion using deep learning methods." Journal of King Saud University – Computer and Information Sciences, vol. 37, pp. 24–37, 2025.

8. Vyas, K., Jain, A., et al. "Implementation of Realtime Image Fusion for Biomedical Applications." International Journal of Electrical and Electronics Research, vol. 12, no. 3, pp. 14–22, 2023. Li, P., Wang, K., et al. "PCA based SVD fusion for MRI and CT medical images." Journal of Intelligent & Fuzzy Systems, vol. 39, no. 1, pp. 853–860, 2020.