*International Journal on Recent and Innovation Trends in Computing and Communication*
***ISSN: 2321-8169 Volume: 11 Issue: 9***
***Article Received:** 25 July 2023 **Revised:** 12 September 2023 **Accepted:** 30 September 2023*

# Starry Night Panorama with Advanced Feature Extraction and Star Stitching

**[1]Dr. Brijesh Kumar Bhardwaj, [2]Akshat Maurya, [3]Ganesh Kumar, [4]Shivanand Yadav, [5]Shivendra Giri**
[1]Associate Professor MCA
Dr. Ram Manohar Lohia Avadh University Ayodhya U.P.
wwwbkb2012@gmail.com
[2]Research Scholar MCA,
Computer Application Department,
Dr. Ram Manohar Lohia Avadh University Ayodhya U.P.
akshatmaurya54@gmail.com
[3]Research Scholar MCA,
Computer Application Department,
Dr. Ram Manohar Lohia Avadh University Ayodhya U.P.
ganesh9170419837@gmail.com
[4]Research Scholar MCA,
Computer Application Department,
Dr. Ram Manohar Lohia Avadh University Ayodhya U.P.
shivanandyadav0001@gmail.com
[5]Research Scholar MCA,
Computer Application Department,
Dr. Ram Manohar Lohia Avadh University Ayodhya U.P.
shivagswm912@gmail.com

***Abstract***—Panoramic photography involves merging multiple photos of the same scene, each with overlapping views, to create a detailed image. When combining astrophotography with panoramic landscapes, challenges arise from image noise and subject motion. To address this, incorporating spatially variant registration steps in the panorama process can merge several shorter exposures into a final image with reduced noise and without motion artifacts. This method tackles two main issues in creating night sky panoramas: low signal-to-noise ratio (SNR) and motion blur.Initially, the images are divided into land and sky segments. Then, potential star locations are identified from a star image. Extracting features from night images is complex, and the Scale-Invariant Feature Transform (SIFT) algorithm is chosen for its robustness to rotation, scale changes, and noise. In astrophotography panoramas, more features need extraction, and SIFT performs well compared to other methods.Next, matching star features between images with common points allows combining two short exposures. A seamless blending technique removes visible seams between merged images. Compensating for star motion involves warping images using local transformations for smooth alignment. Finally, the combined exposures are stitched into a panorama using a spherical projection method.

***Keywords***-Panoramic Photography, Astrophotography, Image Noise, Motion Artifacts, SIFT Algorithm, Spherical Projection

## I. INTRODUCTION

Panorama creation involves merging numerous photographic images into a cohesive representation of a scene, significantly expanding the field of view beyond what a single camera shot can capture. When this technique is applied to capturing the sky, it becomes an Astrophotography panorama, aiming to encompass expansive celestial landscapes. Unlike the limited field of view of human vision, which spans around 135 x 200 degrees, conventional cameras typically offer a narrower perspective of only 35 x 50 degrees. Thus, panoramic imaging involves capturing multiple images and seamlessly stitching them together to create a composite image with an expanded and immersive field of view.

*International Journal on Recent and Innovation Trends in Computing and Communication*
*ISSN: 2321-8169 Volume: 11 Issue: 9*
***Article Received:** 25 July 2023 **Revised:** 12 September 2023 **Accepted:** 30 September 2023*

In the realm of Astrophotography, panoramic techniques are crucial for capturing the grandeur and complexity of celestial bodies and phenomena. By combining multiple sky images, photographers can reveal intricate details and vast expanses that would be impossible to capture in a single frame. This process not only enhances the visual impact but also allows for a comprehensive study of celestial objects and their interactions. Astrophotography panoramas thus serve as powerful tools for scientific exploration and artistic expression, offering a unique perspective on the wonders of the universe.

The creation of Astrophotography panoramas also underscores the integration of technology and creativity in modern photography. Advanced algorithms and stitching techniques enable photographers to merge images seamlessly, overcoming challenges such as image noise and motion artifacts. As a result, Astrophotography panoramas stand as impressive examples of how innovation in imaging technology enhances our ability to capture and appreciate the beauty and complexity of the cosmos.

## II. Literature Study

Panoramic imagery and its applications have garnered significant attention across various domains, driving research in areas such as maintenance management, indoor lighting prediction, depth estimation, and surveillance systems. Zuluaga et al. [1] developed a mobile application for maintenance management, showcasing the integration of technology in optimizing operational workflows. Similarly, Bai et al. [2] focused on local-to-global panorama inpainting for locale-aware indoor lighting prediction, contributing to enhanced environmental modeling. Miao et al. [3] presented variational depth estimation on the hypersphere for panoramas, addressing challenges in accurate scene depth representation.

In the realm of visual data acquisition, Honda et al. [4] proposed a method utilizing borehole camera images and visual SLAM to generate borehole wall panoramas, demonstrating advancements in geological imaging techniques. Ye et al. [5] introduced a learning-based framework for multi-view instance segmentation in panoramas, leveraging machine learning for semantic segmentation tasks. Shi et al. [6], on the other hand, delved into geometry-guided street-view panorama synthesis from satellite imagery, bridging the gap between different imaging modalities.

Furthermore, research efforts have extended to panorama processing techniques such as bias removal blending [7] and non-cooperative airport panorama surveillance [8], highlighting strategies to enhance image quality and security surveillance systems, respectively. Wang and Wang [9] explored virtual reality (VR) panorama-based virtual instruments for music creation, showcasing innovative applications of panoramic technologies in artistic expression.

In the realm of specialized applications, Qiang et al. [10] designed a panorama vehicle-mounted battlefield perception system, integrating multi-light fusion imaging technology for military purposes. Kudinov et al. [11] conducted a comparative analysis of strategies for forming regions of interest in panorama vision systems, contributing insights into optimization techniques for panoramic image processing.

Moreover, advancements in real-time panorama and image stitching [12], robust watermarking for spherical panoramas [13], and high-quality panorama stitching based on optical flow [14] have enriched the panorama processing landscape. Additionally, Gkitsas et al. [15] focused on deep lighting environment map estimation from spherical panoramas, showcasing the synergy between deep learning and panoramic imaging for environmental modeling tasks.

Collectively, these studies underscore the diverse applications and methodologies driving innovation in panoramic imaging, spanning from maintenance management and environmental modeling to military surveillance and artistic expression, while also addressing challenges in image processing, depth estimation, and semantic segmentation in panoramic contexts.

## III. Proposed Methodology

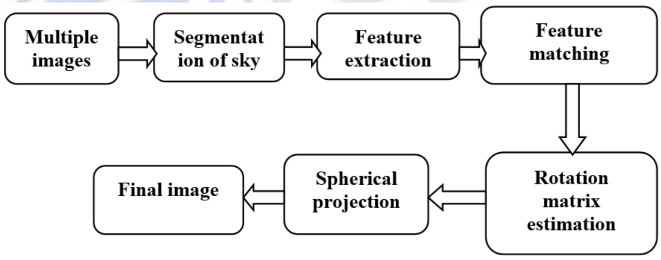


Figure 1. Proposed Methodology

### A. Image segmentation

In the process of creating a panoramic image, the first step involves capturing multiple photographs that encompass both the land and sky. These images are then meticulously separated through image segmentation, a pivotal technique facilitated by OTSU's method. By leveraging the bi-modal histogram of the image, this algorithm discerns between two distinct classes of pixels-foreground and background. Through iterative calculations, it determines an optimal threshold that minimizes the intra-class variance, effectively isolating the land and sky components. Furthermore, the adaptation of the Multi Otsu method enhances this segmentation process by extending it to multi-level thresholding, refining the delineation for panoramic imagery.

### B. Feature Extraction Techniques

- Harris corner detector

The Harris corner detector serves as a foundational technique in extracting salient features within an image. By implementing

*International Journal on Recent and Innovation Trends in Computing and Communication*
***ISSN: 2321-8169 Volume: 11 Issue: 9***
***Article Received:** 25 July 2023 **Revised:** 12 September 2023 **Accepted:** 30 September 2023*

the Moravec algorithm, this method analyzes changes in intensity within localized windows, identifying areas of interest based on directional intensity alterations. It categorizes these areas into flat regions, edge regions, and corner regions, providing a comprehensive understanding of the image's structure and content.

- Hessian detector

The Hessian detector contributes to robust feature matching by utilizing the determinant of the Hessian function as a saliency operator. This technique excels in identifying corners and edges across varying orientations, leveraging the matrix of second-order partial derivatives to define the image's Hessian with respect to coordinates. Through this approach, it discerns strong edges, corners, and blobs, facilitating accurate feature extraction and matching.

### *C. Advanced Feature Extraction*

- SURF (Speeded-Up Robust Feature)

The SURF algorithm revolutionizes feature extraction through its integration of multi-scale space theory and fast Hessian matrix approximations. By optimizing the detection, description, and matching processes, SURF significantly accelerates computations while maintaining high-quality feature points. Its utilization of low-dimensional descriptors and efficient Hessian matrix computations enhances speed without compromising accuracy, making it a preferred choice in panoramic image processing and computer vision applications.

- SIFT (Scale-Invariant Feature Transform)

SIFT stands out for its robustness against scale changes, rotations, and exposure variations. By dividing the image into scale-invariant coordinates, it ensures that extracted features remain consistent across different viewing conditions. The algorithm's multi-stage approach, including scale space extrema search, keypoint localization, orientation assignment, and keypoint descriptor generation, yields highly distinctive and invariant features. This makes SIFT a valuable tool for panoramic image analysis and feature-based matching tasks.
Image Stitching

### *D. IMAGE STITCHING*

Image stitching is a sophisticated process that combines multiple photographic images with overlapping fields of view to create a seamless panorama or a high-resolution composite image. This technique can be broken down into three key components: calibration, image registration, and blending, each playing a vital role in achieving a cohesive and visually appealing final output.

- Calibration

Calibration is a critical step in image stitching aimed at minimizing discrepancies between an ideal lens model and the actual camera-lens configuration used during image capture. These discrepancies often arise due to optical imperfections like distortions and exposure variations across images. During calibration, both intrinsic and extrinsic camera parameters are recovered to reconstruct the 3D structure of a scene from pixel coordinates. Extrinsic parameters define the camera's location and orientation relative to a known world reference frame, while intrinsic parameters establish the relationship between pixel coordinates and the camera's reference frame.

- Registration

Image registration is the heart of the stitching process, focusing on creating geometric alignment between images through feature matching. This involves comparing features across images to identify correspondences, enabling subsequent steps to be applied accurately. Image registration essentially aligns multiple images captured from different perspectives, ensuring seamless integration into a cohesive panorama.

- Feature Matching

Feature matching plays a pivotal role in image registration by identifying common features between images. By analyzing feature matches, images with a significant number of matches can be selected for further processing. Techniques like RANSAC (Random Sample Consensus) are employed to robustly estimate image transformation parameters and select inliers that are compatible with a homography between images. RANSAC iteratively samples correspondences to compute a homography that maximizes consensus with the data, ensuring accurate alignment and stitching of images.

- Blending

Blending is the final step in image stitching, where the tracked features are used to estimate camera motion and model the camera's 3D rotation between images. Typically, minor camera movements during image capture are modeled as 3D rotations without compromising accuracy. The resulting rotation matrix facilitates the transformation of images onto a spherical surface using spherical projection. This projection technique preserves scaling and alignment, crucial for maintaining the integrity of the stitched panorama. Overall, blending ensures smooth transitions and alignment of frames, resulting in a visually cohesive and high-quality panoramic image.

## IV. RESULTS

Figure 2. Origional image

*International Journal on Recent and Innovation Trends in Computing and Communication*
***ISSN: 2321-8169 Volume: 11 Issue: 9***
***Article Received:** 25 July 2023 **Revised:** 12 September 2023 **Accepted:** 30 September 2023*

Figure 3. Gray image

Figure 4. Segmentation (sky)

Figure 5. Segmentation (Land)

Figure 6. Feature extraction using Harris Detector

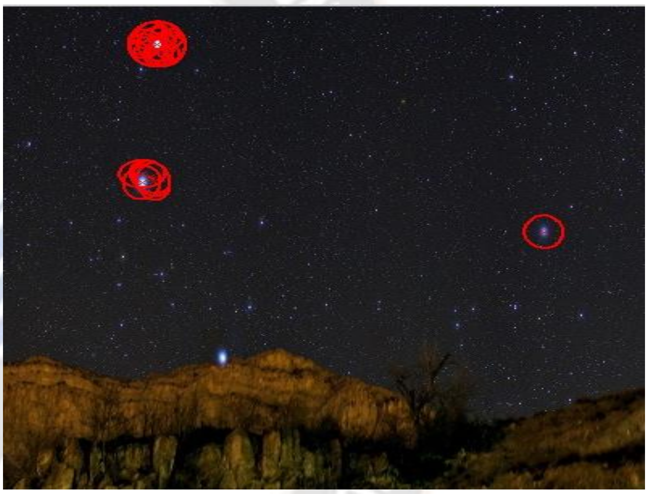

Figure 7. Feature extraction using Hassian Detector

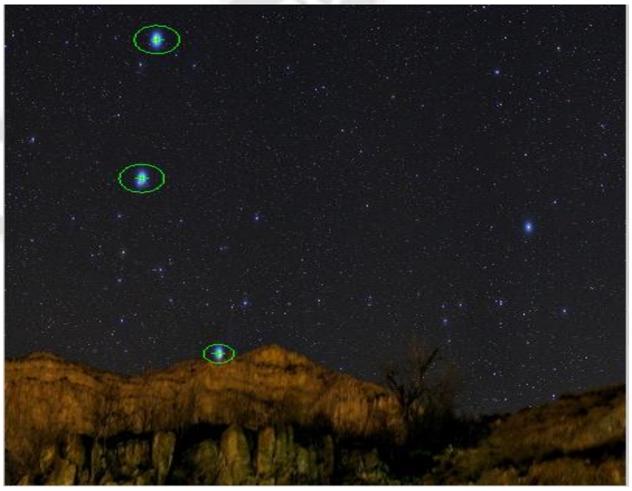

Figure 8. Feature extraction using SURF

Figure 9. Feature extraction using SIFT

## COCNLUSION

In conclusion, creating night sky panoramas presents significant challenges due to low signal-to-noise ratio (SNR) and motion blur. To overcome these obstacles, the incorporation of advanced feature extraction techniques, particularly Scale-Invariant Feature Transform (SIFT), becomes crucial. SIFT allows for the extraction of a greater number of features, essential for capturing the intricate details of night scenes.

Additionally, spatially variant registration steps were introduced into the panorama workflow. This innovative approach enabled the algorithm to merge multiple shorter exposures effectively, resulting in a final image with reduced noise and free from motion artifacts. Deblurring techniques such as using light streaks further enhanced the clarity of the image, ensuring a visually pleasing panorama.

Furthermore, the process involved matching extracted features and projecting them onto the appropriate surface, contributing to the seamless creation of the final panorama. Overall, by addressing the challenges of low SNR and motion blur through feature-rich extraction, spatially variant registration, and deblurring techniques, the algorithm successfully produced high-quality night sky panoramas.

## REFERENCES

[1] A. E. M. Zuluaga, E. E. G. De Mantenimiento, and C. S. Marcos, “Development of a Mobile Application for Maintenance Management,” in 2023 VI Congreso Internacional en Inteligencia Ambiental, Ingeniería de Software y Salud Electrónica y Móvil (AmITIC), 2023, pp. 1–8. doi: 10.1109/AmITIC60194.2023.10366367.

[2] J. Bai et al., “Local-to-Global Panorama Inpainting for Locale-Aware Indoor Lighting Prediction,” IEEE Transactions on Visualization and Computer Graphics, vol. 29, no. 11, pp. 4405–4416, 2023, doi: 10.1109/TVCG.2023.3320233.

[3] J. Miao, Y. Liu, K. Wang, J. Liu, and Z. Xu, “Variational Depth Estimation on Hypersphere for Panorama,” in 2022 IEEE International Conference on Image Processing (ICIP), 2022, pp. 866–870. doi: 10.1109/ICIP46576.2022.9897914.

[4] K. Honda, M. Nakao, and T. Kagawa, “A Method to Generate a Borehole Wall Panorama using Borehole Camera Images and Visual SLAM,” in 2022 7th International Conference on Intelligent Informatics and Biomedical Science (ICIIBMS), 2022, vol. 7, pp. 382–385. doi: 10.1109/ICIIBMS55689.2022.9971666.

[5] W. Ye, Z. Mai, Q. Zhang, and X. Wang, “A Learning-based Framework for Multi-View Instance Segmentation in Panorama,” in 2022 IEEE 9th International Conference on Data Science and Advanced Analytics (DSAA), 2022, pp. 1–9. doi: 10.1109/DSAA54385.2022.10032431.

[6] Y. Shi, D. Campbell, X. Yu, and H. Li, “Geometry-Guided Street-View Panorama Synthesis From Satellite Imagery,” IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 44, no. 12, pp. 10009–10022, 2022, doi: 10.1109/TPAMI.2022.3140750.

[7] S. Mahakud and P. Roy, “Bias Removal Blending to Create Panorama,” in 2021 2nd International Conference on Range Technology (ICORT), 2021, pp. 1–6. doi: 10.1109/ICORT52730.2021.9581902.

[8] C. Xia, C. Hou, X. Pei, J. Zhong, and C. Yang, “Non-cooperative Airport Panorama Surveillance,” in 2021 IEEE 3rd International Conference on Civil Aviation Safety and Information Technology (ICCASIT), 2021, pp. 1344–1347. doi: 10.1109/ICCASIT53235.2021.9633530.

[9] H. Wang and H. Wang, “Method for Creation of Original Music by the VR Panorama Based Virtual Instrument,” in 2021 International Conference on Culture-oriented Science & Technology (ICCST), 2021, pp. 330–333. doi: 10.1109/ICCST53801.2021.00075.

[10] G. Qiang, W. Zhen-Nan, Z. Ming-Xing, and M. Wei-Qun, “Design and implementation of panorama vehicle-mounted battlefield perception system based on multi-light fusion imaging technology,” in 2021 2nd International Conference on Computer Communication and Network Security (CCNS), 2021, pp. 80–83. doi: 10.1109/CCNS53852.2021.00024.

[11] I. A. Kudinov, M. B. Nikiforov, and I. S. Kholopov, “Comparative analysis of two strategies for forming regions of interest in panorama vision system,” in 2021 International Conference on Information Technology and Nanotechnology (ITNT), 2021, pp. 1–4. doi: 10.1109/ITNT52450.2021.9649226.

[12] S. Degadwala, U. Chakraborty, P. Kuri, H. Biswas, A. N. Ali, and D. Vyas, “Real-Time Panorama and Image

Stitching with Surf-Sift Features," in 2021 6th International Conference on Inventive Computation Technologies (ICICT), 2021, pp. 1111–1115.

[13] J. Kang, J.-U. Hou, S. Ji, and H.-K. Lee, "Robust Spherical Panorama Image Watermarking Against Viewpoint Desynchronization," IEEE Access, vol. 8, pp. 127477–127490, 2020, doi: 10.1109/ACCESS.2020.3006980.

[14] M. Meng and S. Liu, "High-quality Panorama Stitching based on Asymmetric Bidirectional Optical Flow," in 2020 5th International Conference on Computational Intelligence and Applications (ICCIA), 2020, pp. 118–122. doi: 10.1109/ICCIA49625.2020.00030.

[15] V. Gkitsas, N. Zioulis, F. Alvarez, D. Zarpalas, and P. Daras, "Deep Lighting Environment Map Estimation from Spherical Panoramas," in 2020 IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (CVPRW), 2020, pp. 2719–2728. doi: 10.1109/CVPRW50498.2020.00328.