# Yunfan Lu | Research Statement

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## Research Aim

Accurate perception is fundamental for intelligent systems, and pushing its limits is essential to surpass biological vision. My research aims to transform computational imaging through novel event-based sensors and agile algorithms, addressing critical limitations of traditional visual systems—such as limited dynamic range, motion blur, poor low-light performance, restricted multispectral capabilities, and processing inefficiencies. My objective is to overcome these challenges through an integrated approach that combines optical design, advanced sensors, and innovative algorithms.

Specifically, my research pursues two interconnected goals. First, I develop advanced imaging algorithms leveraging the unique strengths of event-based vision sensors to address key issues such as high dynamic range imaging [6], low-light enhancement [7], deblurring [3,11], rolling shutter correction [3,9], frame interpolation [3,5], and super-resolution [10]. This unified framework will effectively handle complex, coupled imaging degradations in real-world environments. Second, to ensure real-world applicability, I pioneer fully integrated computational imaging systems through joint sensor-algorithm co-design [1]. These systems will deliver efficient [2] and robust solutions tailored for practical scenarios in industry, robotics, autonomous vehicles, and drones, enabling reliable perception under extreme conditions of rapid motion and significant illumination changes.

By merging theoretical innovation with practical hardware-algorithm co-design, my research seeks to redefine machine vision, enhancing adaptability and agility beyond biological capabilities, laying a robust foundation for next-generation visual intelligence.

## Research Experience

My research explores critical questions in enhancing modern imaging systems through event-based sensors, addressing fundamental challenges posed by conventional cameras. Specifically, my work investigates three interconnected dimensions:

**Exploiting High Temporal Resolution:** To fully leverage the microsecond-level temporal precision of event cameras, I have developed innovative methodologies for capturing instantaneous motion and modeling long-term dependencies [5]. My notable works include Temporal Pyramid Representation for capturing rapid motions within milliseconds and the Long-Term Embedding Scheme designed to model continuous motion across multiple frames [5]. These techniques effectively tackle complex imaging problems like deblurring [3,11], rolling shutter correction [3,9], super-resolution [10], and frame interpolation, significantly improving performance in dynamic, real-world conditions.

**Leveraging High Dynamic Range:** My research utilizes the inherent high dynamic range of event cameras to redefine illumination enhancement [4]. I framed adaptive brightness adjustment as a prompt-based regression task, enabling flexible and precise control of image brightness across diverse lighting conditions. Additionally, by constructing large-scale, precisely aligned datasets through robotic arms and inertial measurement unit calibration [6,7], my methodologies have demonstrated clear advantages in practical scenarios, significantly boosting the performance of downstream vision tasks such as depth estimation and segmentation [7].

**Aligning with Human Visual Perception:** Recognizing the importance of human-centric imaging, I contributed the first event-guided Image Signal Processing (ISP) dataset designed specifically for hybrid vision sensors [1,2,8]. This dataset facilitates breakthroughs in color correction, demosaicing, and denoising, aligning closely with human visual expectations. Furthermore, I developed a binarized semantic transformer framework that significantly accelerates network processing speed, ensuring that these advanced visual processing capabilities remain practical and efficient for deployment in real-world scenarios.

Through these focused yet interconnected research directions, my work not only addresses theoretical challenges but also creates practical, robust, and integrated imaging systems, bridging scientific exploration with tangible industrial and technological applications.

## Future Directions

Moving forward, my research will delve deeper into integrated end-to-end system design, closely combining innovative sensor design with tailored algorithmic frameworks. Specifically, I plan to pursue joint optimization techniques that harmonize the hardware aspects of novel event-based sensors with adaptive computational imaging algorithms, thereby creating highly efficient and specialized imaging systems. Additionally, I aim to explore the incorporation of generative models into computational photography, enabling advanced image restoration and synthesis tasks, enhancing robustness and adaptability to diverse real-world conditions. Furthermore, I will investigate multimodal integration, combining visual and tactile sensing, particularly within applications involving robotics and drones. This comprehensive approach aims to enhance perceptual capabilities and situational awareness in complex scenarios, pushing the boundaries of intelligent sensing and interaction in practical environments.

## Selected Works (Refereed)


[1] **Lu, Y.,** Qian, Y., Rao, Z., Xiao, J., & Xiong, H. (2025). RGB-Event ISP: The Dataset and Benchmark. In **ICLR**.

[2] Zhou, S., Zeng, H., **Lu, Y.,** Shao, T., Chen, Y., Liu, J., & Su, J. (2025). Binarized Semantic Mamba-Transformer for Lightweight Quad Bayer HybridEVS Demosaicing. In **CVPR**.

[3] **Lu, Y.,** Liang, G., Wang, Y., Wang, L., & Xiong, H. (2025). UniINR: Event-Guided Unified Rolling Shutter Correction, Deblurring, and Interpolation. In **ECCV**.

[4] Wang, Z., **Lu, Y.,** & Wang, L. (2025). Revisit Event Generation Model: Self-Supervised Learning of Event-to-Video Reconstruction with Implicit Neural Representations. In **ECCV**.

[5] **Lu, Y.,** Wang, Z., Wang, Y., & Xiong, H. (2024). Continuous Space-Time Video Super-Resolution via Event Camera. arXiv preprint arXiv:2405.13389.

[6] **Lu, Y.,** Xu X, Lu H, et al. (2023) SEE: See Everything Every Time--Adaptive Brightness Adjustment for Broad Light Range Images via Events. arXiv preprint arXiv:2502.21120, 2025..

[7] Liang, G., Chen, K., Li, H., **Lu, Y.,** & Wang, L. (2024). Towards Robust Event-guided Low-Light Image Enhancement: A Large-Scale Real-World Event-Image Dataset and Novel Approach. In **CVPR**.

[8] **Lu, Y.,** Xu, Y., Ma, W., Guo, W., & Xiong, H. (2024). Event Camera Demosaicing via Swin Transformer and Pixel-focus Loss. In **CVPRW**.

[9] **Lu, Y.,** Liang, G., & Wang, L. (2023). Self-supervised Learning of Event-guided Video Frame Interpolation for Rolling Shutter Frames. arXiv preprint arXiv:2306.15507.

[10] **Lu, Y.,** Wang, Z., Liu, M., Wang, H., & Wang, L. (2023). Learning Spatial-Temporal Implicit Neural Representations for Event-Guided Video Super-Resolution. In **CVPR**.

[11] Wang, Y., **Lu, Y.,** Gao, Y., Wang, L., Zhong, Z., Zheng, Y., & Yamashita, A. (2022, October). Efficient video deblurring guided by motion magnitude. In **ECCV**.