Indo/US Collaborative Research Grants

National Science Foundation of US and Technology Innovation Hubs of India

Title: Enhancing Autonomous and Assisted Driving using Thermal-RGB Fusion
Indian PI: Prof. Kaushik Mitra, IIT Madras
US PI: Prof. Aswin Sankaranarayanan, Carnegie Mellon University

Common driving occurrences like sun-glare, low-light, fog and headlight glare are hurdles to ADAS systems that rely on RGB cameras for sensing. A common way to mitigate this is to use LiDAR sensors. However, LiDAR systems are extremely expensive, bulky and also have difficulties working in bad weather conditions such as heavy rain, snow or fog. In contrast, thermal images are unaffected by these conditions which makes thermal cameras suitable candidates as sensors for use in ADAS systems. In this project, we aim to solve three sub-problems as listed: For the first sub-problem, our goal is to enhance extremely low light RGB images using the assistance of the thermal image. We developed a deep architecture for solving this problem using a synthesized dataset based on a novel physics-based model. Using thermal guidance along with RGB for restoration gives a significant boost in performance compared to using just RGB. For the second sub-problem, we want to super-resolve low-resolution thermal images using RGB as a guide. We transfer relevant high-frequency details from the RGB image to the thermal image using a novel cross-attention mechanism even when the RGB-Thermal pairs are not aligned. The third sub-problem is that of depth estimation from thermal stereo images. We port state-of-the-art deep networks that work on RGB images to the thermal domain. We also explore a self-supervised learning framework using image-to-image domain translation techniques to combat dataset limitations.

Figure 1 Low light RGB image enhancement using thermal image as guide.

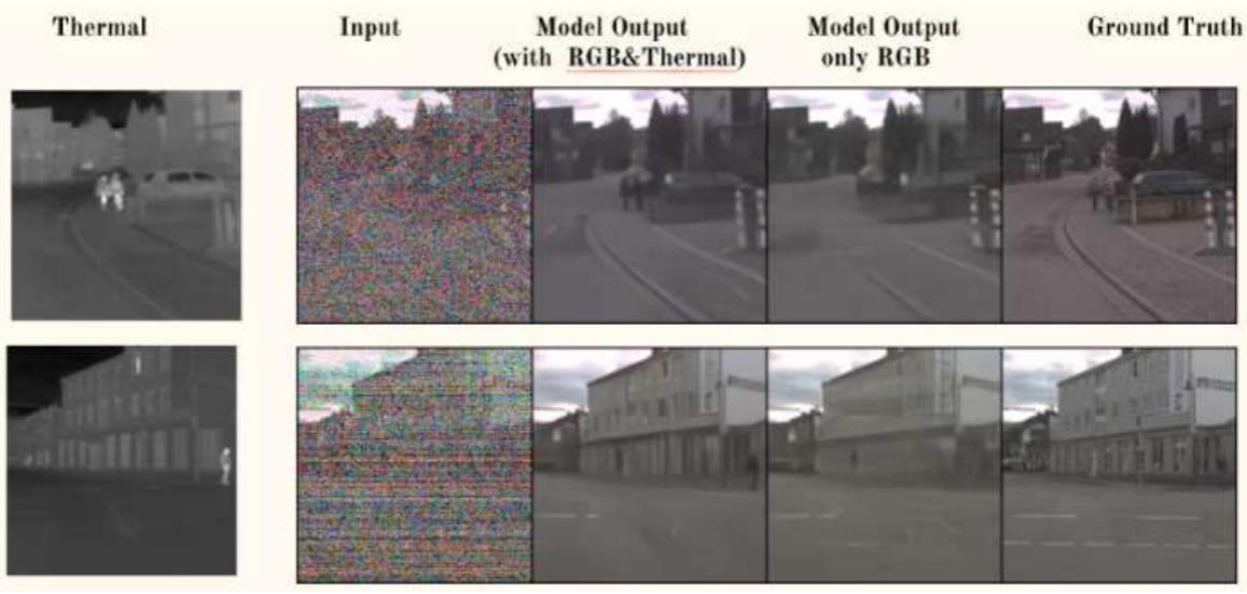

Figure 2 Guided super-resolution of thermal images

Bicubic Upsampled | Model output | Ground Truth

Figure 3 Image domain translation for self supervision

RGB image (input) | Translated thermal image | Reconstructed RGB image