先端科学技術研究科　修士論文要旨

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要旨

Recent advances in image generation and image-to-image translation techniques have significantly expanded the capability of intelligent visual perception systems. These technologies enable the synthesis of images across different visual modalities and have been successfully applied to various tasks, such as image restoration, style transfer, semantic image synthesis, and cross-modal image translation. Among these applications, RGB-to-thermal image translation has attracted increasing attention because it enables thermal information to be estimated from low-cost RGB images without requiring dedicated thermal cameras. This capability has great potential for intelligent cooking systems, where thermal information provides valuable cues for monitoring the cooking process.

However, RGB-to-thermal image translation in cooking scenes remains challenging because the thermal distribution of food depends not only on its visual appearance but also on the cooking process. Food at different cooking stages may exhibit similar RGB appearances while corresponding to significantly different thermal distributions. Furthermore, cooking operations such as food flipping introduce abrupt changes in thermal patterns that cannot be inferred from a single RGB image alone.

To address these challenges, this thesis proposes an RGB-to-thermal image translation framework using cooking-related conditions. In addition to the current RGB image, the proposed framework incorporates an initial RGB image captured before heating, a heating-progress condition that represents the duration since the beginning of the heating, and a flipping-state condition indicating whether the food has been flipped. These cooking-related conditions are integrated into a conditional diffusion model to guide thermal image generation throughout the cooking process.

Experiments are conducted on a paired RGB-thermal cooking dataset collected using synchronized RGB and thermal cameras. Quantitative evaluations based on image quality metrics and thermal distribution analysis demonstrate that incorporating cooking-related conditions significantly improves RGB-to-thermal image translation compared with methods using only the current RGB image. The generated thermal images exhibit higher consistency with the ground-truth thermal distributions under various cooking stages.

The results demonstrate that introducing cooking-related conditions effectively reduces the ambiguity between RGB appearance and thermal distribution, leading to more accurate thermal image generation in cooking scenes. The proposed framework provides a promising approach for RGB-based thermal perception and has the potential to support future intelligent cooking systems.