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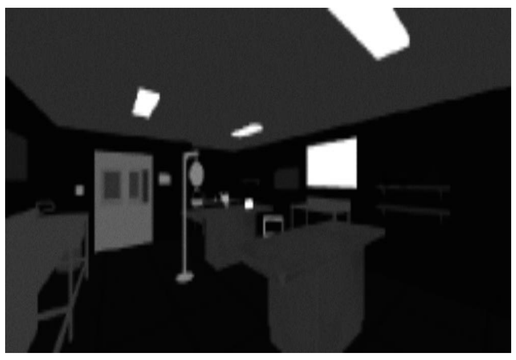
AR in VR
SIMULATING INFRARED AUGMENTED VISION

We propose an augmented reality simulation in a virtual environment to alleviate the difficulties in testing AR systems in the real world. We simulate a thermal camera and then develop an AR screen to mix background and display light. We ask users to locate targets under varying visibility conditions in order to evaluate the performance of different fusion methods.

Thermal Camera

We assign temperature and emission properties to all objects in the scene. A simulated thermal camera uses these values to render a thermal map of the scene in Unity3D.

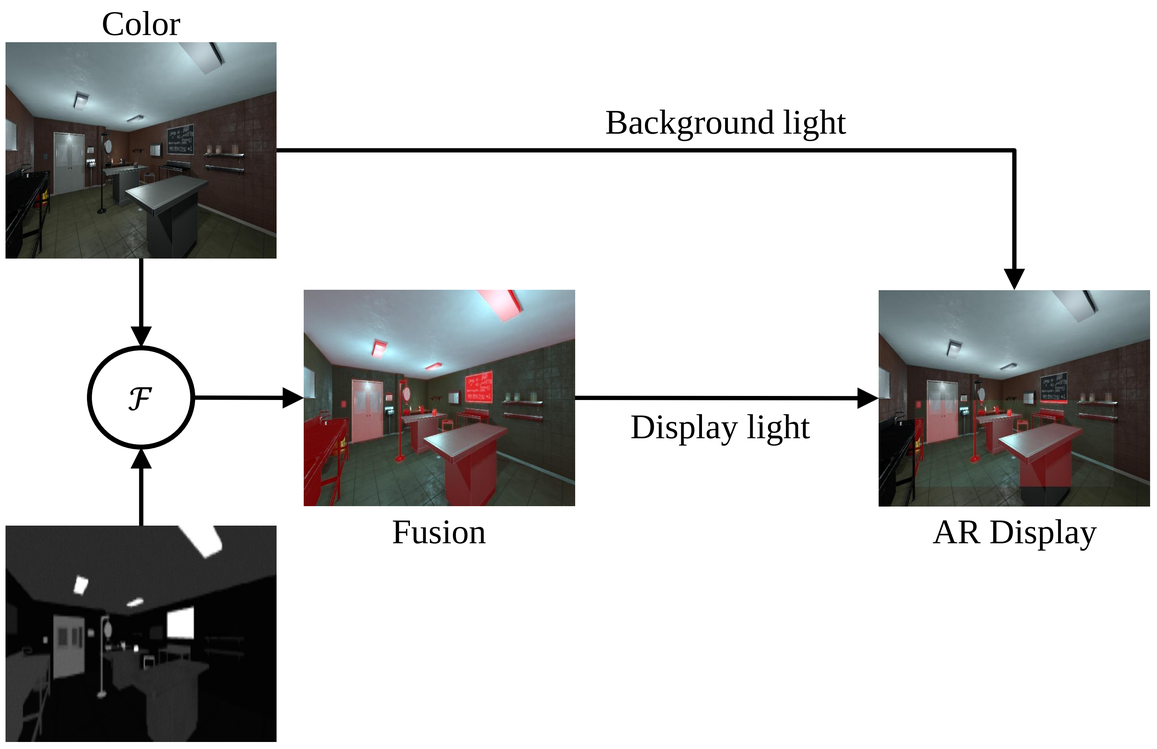

Simulated Visible



Simulated Thermal

Augmented Reality Simulation

A fusion algorithm $\mathcal{F}$ merges both visible and thermal images and projects the fusion on top of a simulated AR display.



Fusion Algorithms

We implement the fusion methods proposed in VisMerge [1].


$\mathcal{F}_1$ Spectral Compression


$\mathcal{F}_2$ Noise Modulation


$\mathcal{F}_3$ Binary Blending


$\mathcal{F}_4$ Adaptive Blending


$\mathcal{F}_5$ Inverse


$\mathcal{F}_6$ Inverse Square

Visibility Conditions


Darkness


Smoke

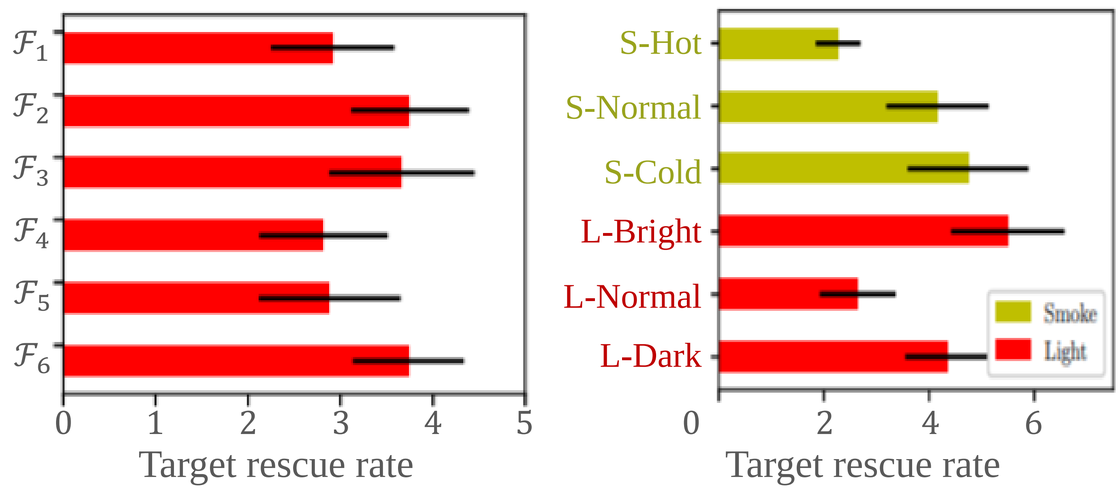
Target Detection Experiment

Experiments in VR are reliable to test AR systems [2]. A target detection experiment allowed us to understand how different fusion methods behave under changing visibility conditions. Overall, Noise Modulation ($\mathcal{F}_2$) performed the best.

Scenarios	Name	Fusion	Light	Smoke
Fusion	F-Spectral	$\mathcal{F}_1$	Normal	Off
	F-Noise	$\mathcal{F}_2$		
	F-Binary	$\mathcal{F}_3$		
	F-Adaptive	$\mathcal{F}_4$		
	F-Inverse	$\mathcal{F}_5$		
	F-InverseSq	$\mathcal{F}_6$		
Light	L-Normal	$\mathcal{F}_{best}$	Normal	Off
	L-Dark		Dark	
	L-Bright		Bright	
Smoke	S-Normal	$\mathcal{F}_{best}$	Normal	Off
	S-Cold			Cold
	S-Hot			Hot

Scenarios

Our framework allows building, running, and controlling different scenarios while testing for multiple factors.



References

[1] O. Jason, K. Peter, K. Kiyoshi, M. Tomohiro, R. Photchara, U. Yuki, and T. Haruo, “Vismerge: Light adaptive vision augmentation via spectral and temporal fusion of nonvisible light,” ISMAR 2017.
[2] C. Lee, S. Bonebrake, T. Hollerer, and D. A Bowman, “A replication study testing the validity of AR simulation in VR for controlled experiments,” ISMAR 2009.