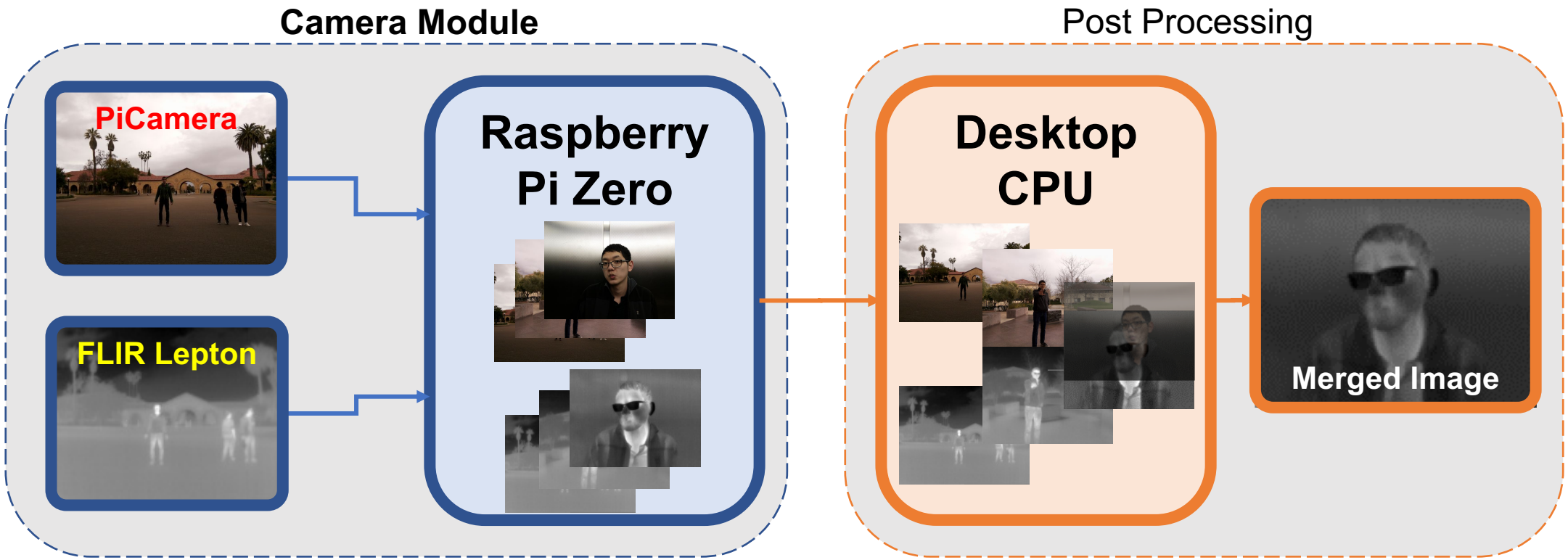
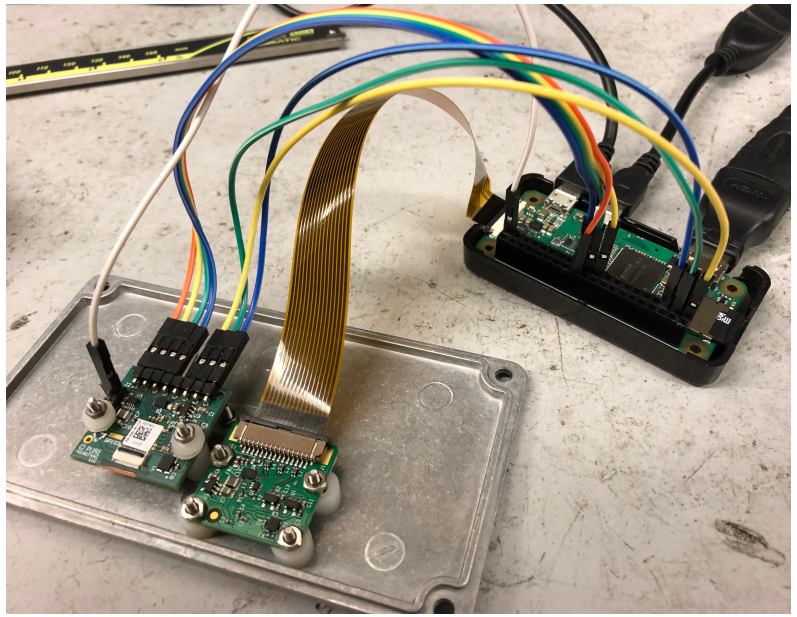
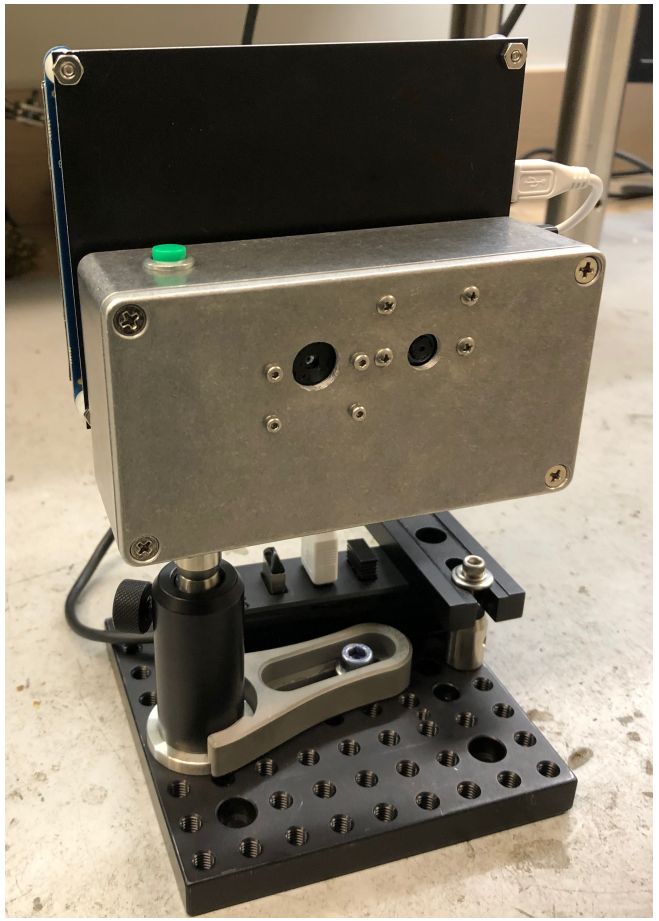
High-Resolution Thermal Imaging with a Handheld VIS+LWIR Camera

Jacob Hines Evan Wang


Camera Module
Post Processing
PiCamera
FLIR Lepton
Raspberry Pi Zero
Desktop CPU
Merged Image

Camera Module

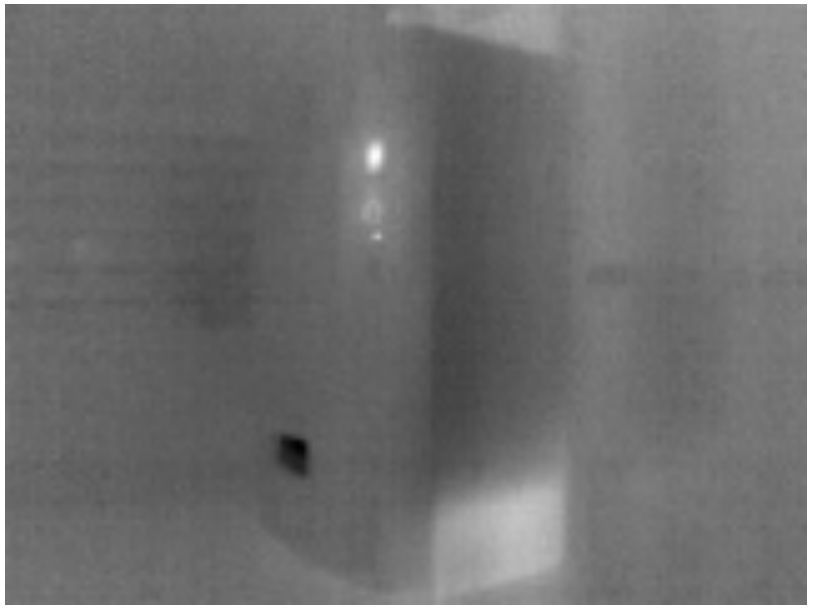







CAUTION
AUTOMATIC
DOOR
Coca-Cola


Coca-Cola

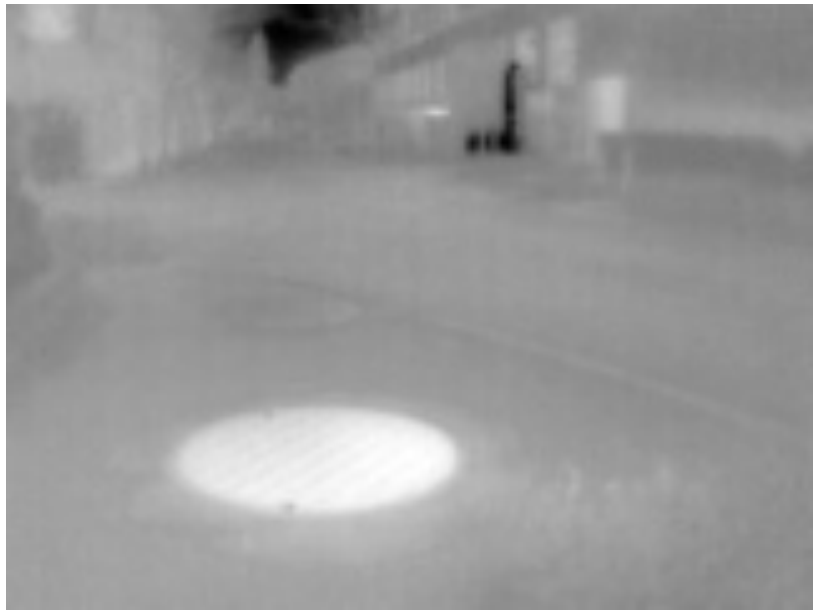
















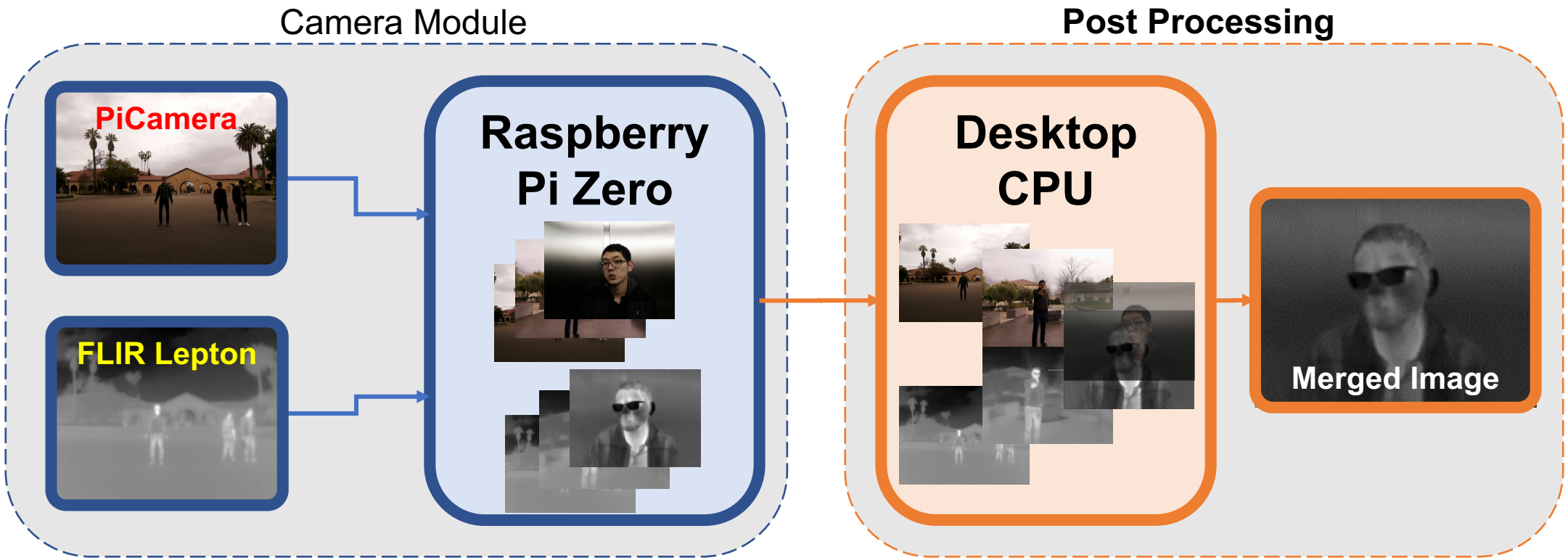
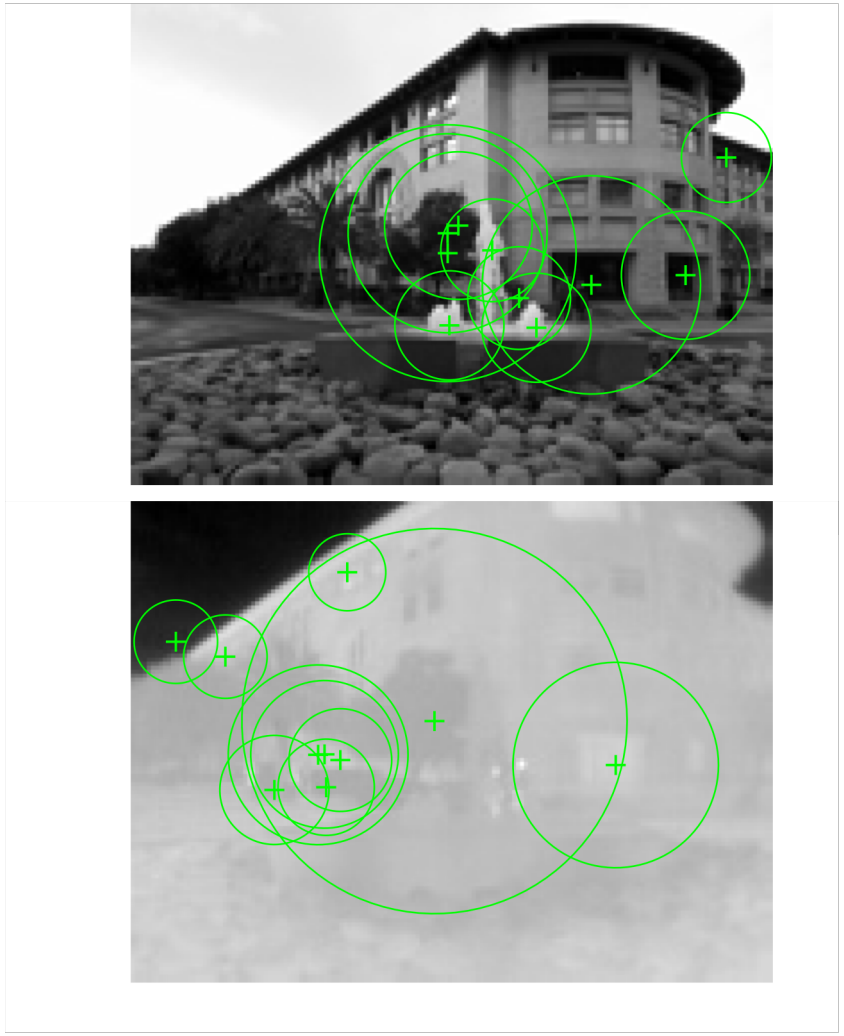
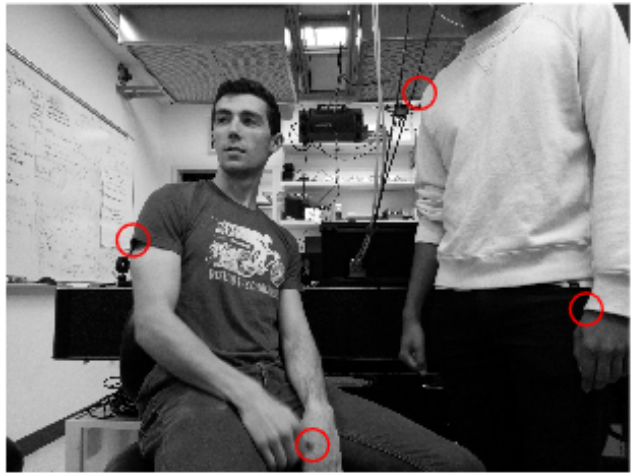
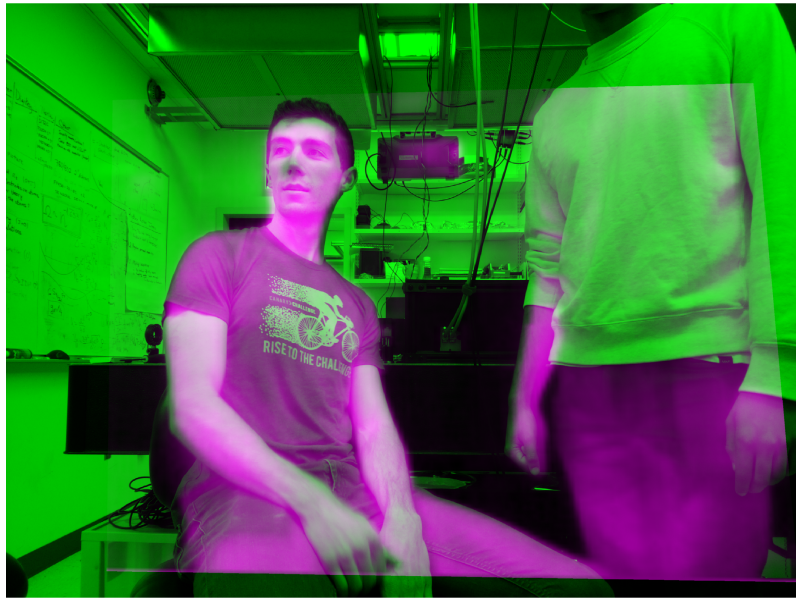

Camera Module
PiCamera
FLIR Lepton
Raspberry
Pi Zero
Post Processing
Desktop
CPU
Merged Image

Image Registration









Fusion: Multiresolution Analysis

$$\widehat{\boldsymbol{M}} = \widetilde{\boldsymbol{M}} + g(\boldsymbol{P} - \boldsymbol{P_L})$$

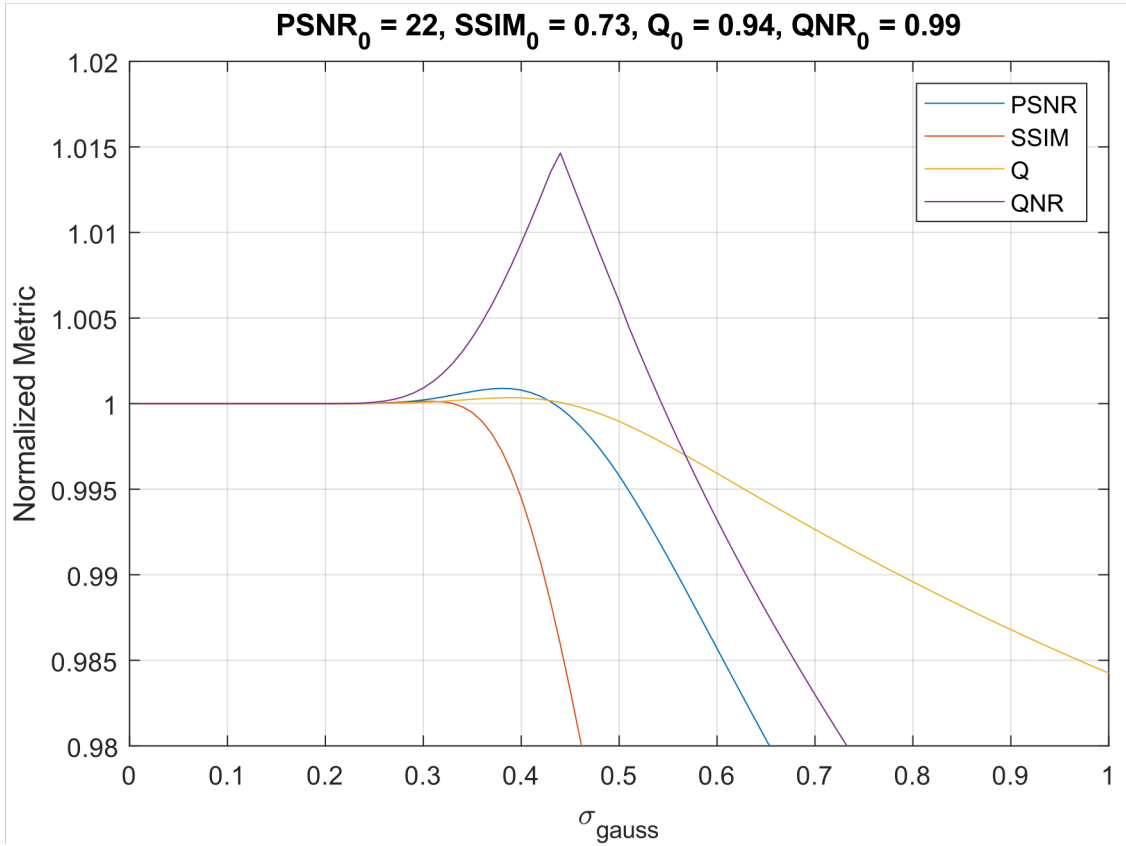
$\widehat{\boldsymbol{M}}$: Fused image
$\widetilde{\boldsymbol{M}}$: low resolution thermal image
$\boldsymbol{P}$: visible image
$\boldsymbol{P_L}$: low-passed visible image
g: injection weight

$\boldsymbol{P}$ $\widetilde{\boldsymbol{M}}$



OSU Color-Thermal Database

High Pass Filtering (HPF)



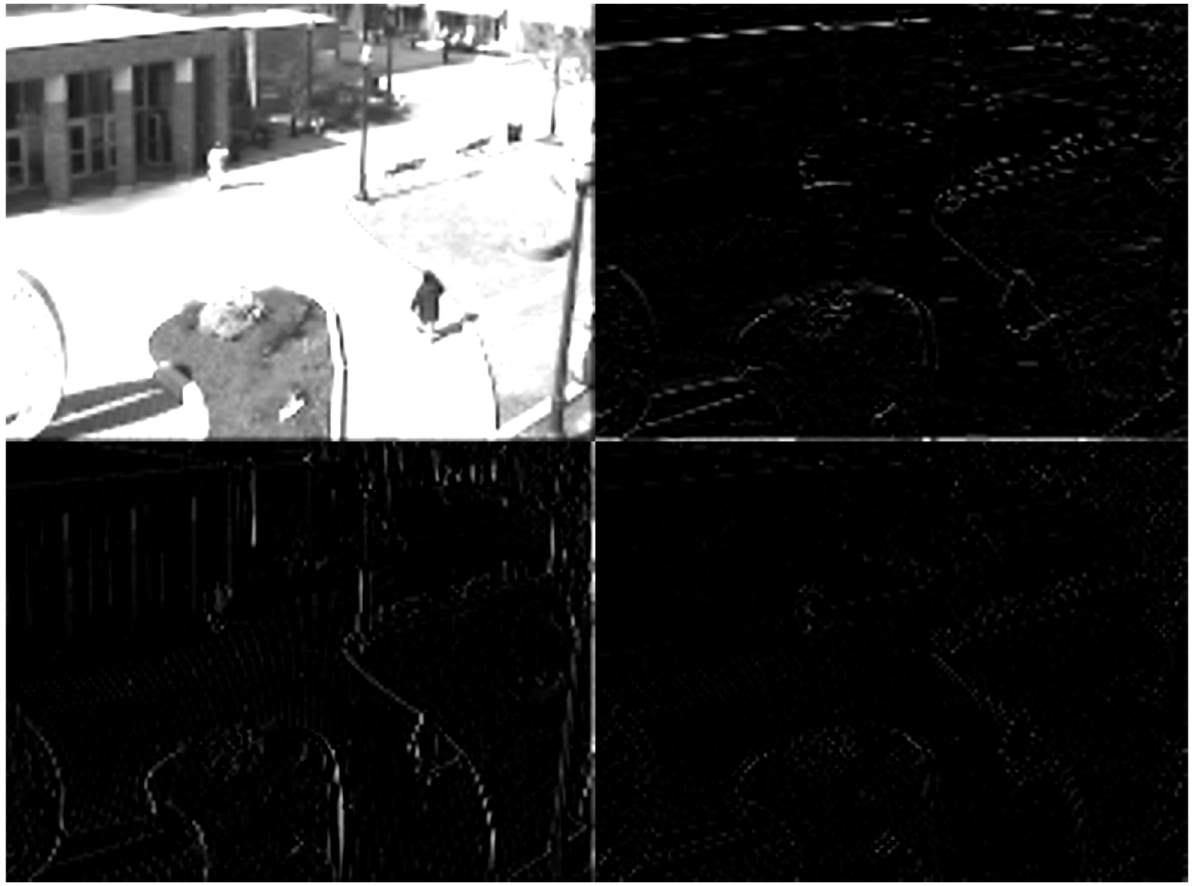
$\sigma = 0$

$\sigma = 0.44$

$\sigma = 1$



Wavelet Fusion





PSNR = 22.00

QNR = 0.9857



PSNR = 21.08

QNR = 1.009

Gradient Transfer Fusion

$$\mathcal{E}(\mathbf{x}) = \frac{1}{p}\|\mathbf{x}-\mathbf{u}\|_p^p + \lambda\frac{1}{q}\|\nabla\mathbf{x}-\nabla\mathbf{v}\|_q^q$$

$\boldsymbol{x}$: Fused image
$\boldsymbol{u}$: thermal image
$\boldsymbol{v}$: visible image

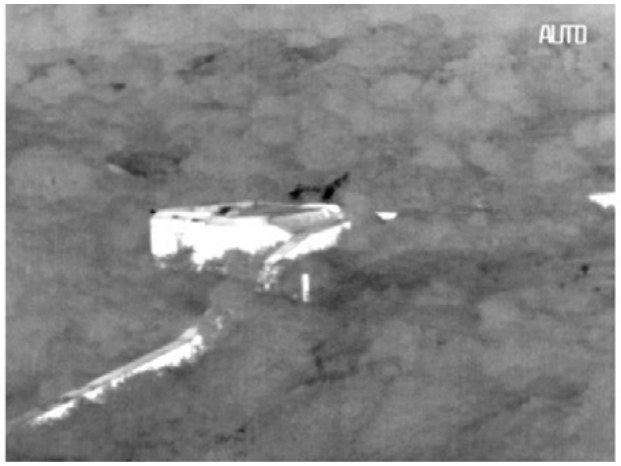
First term: keep thermal intensity information

Second term: acquire visible gradients

Visible



Thermal



MST

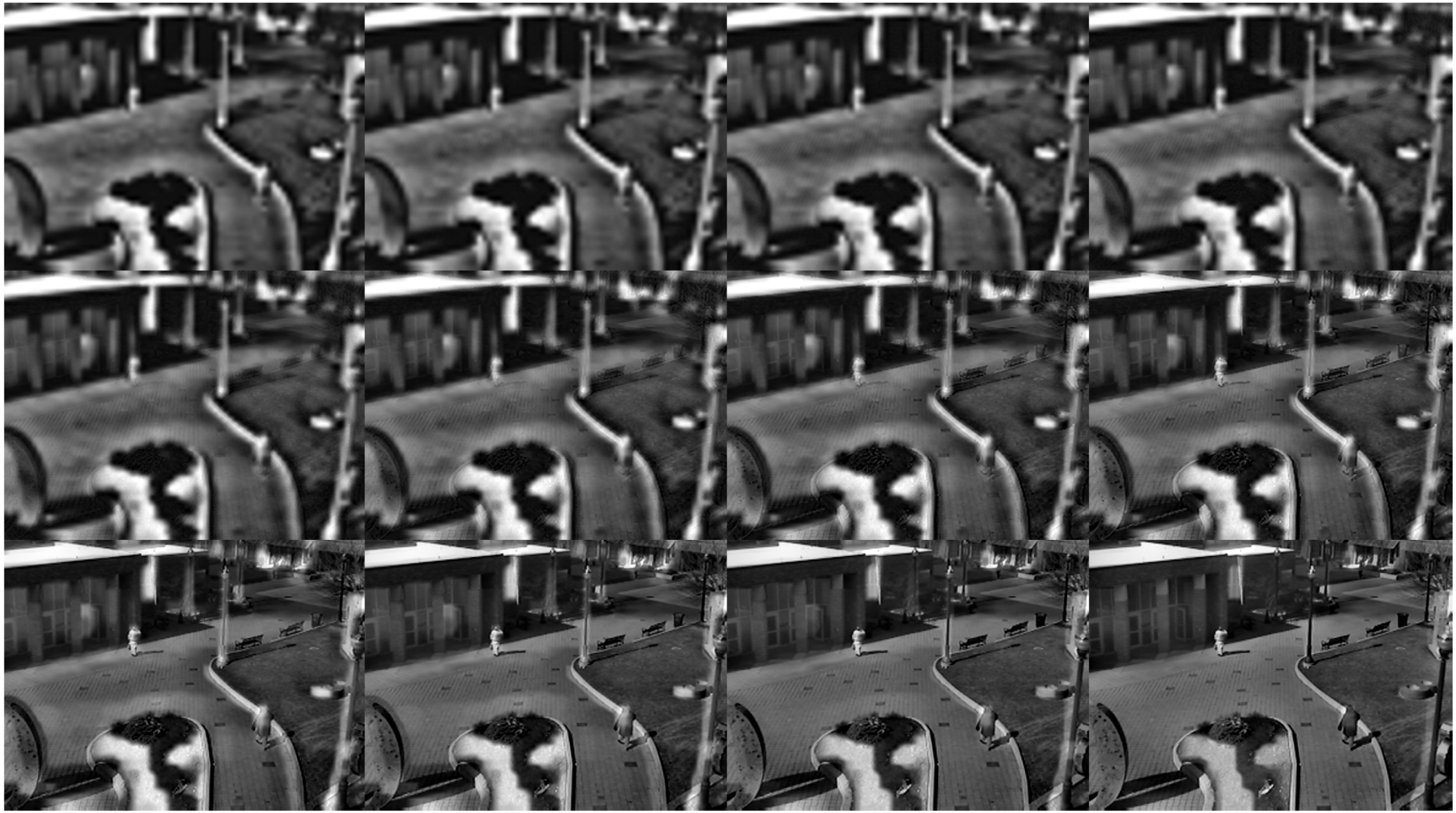


Gradient Transfer + TV

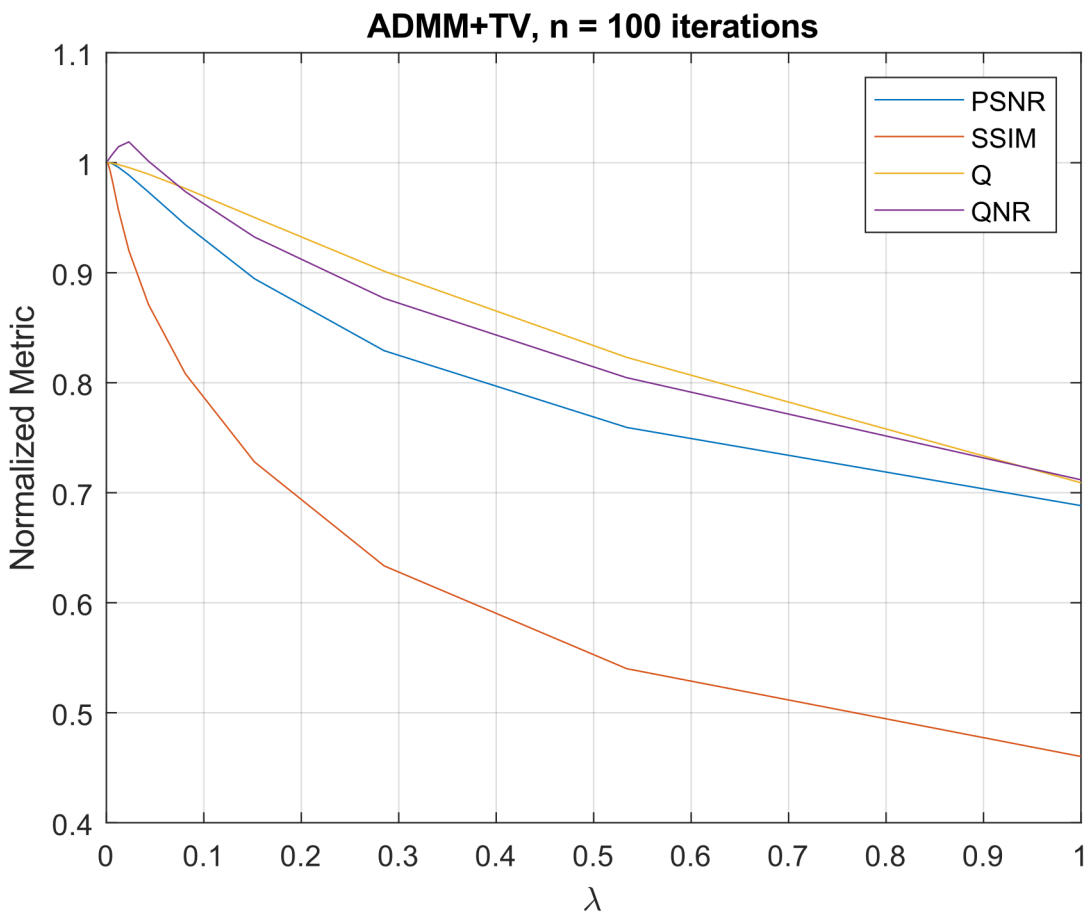


J. Ma *et al., https://doi.org/10.1016/j.inffus.2016.02.001*

$\lambda = 0$



$\lambda = 1$



ADMM+TV, λ = 0.023101



Questions