

# -Accelerated Stereo

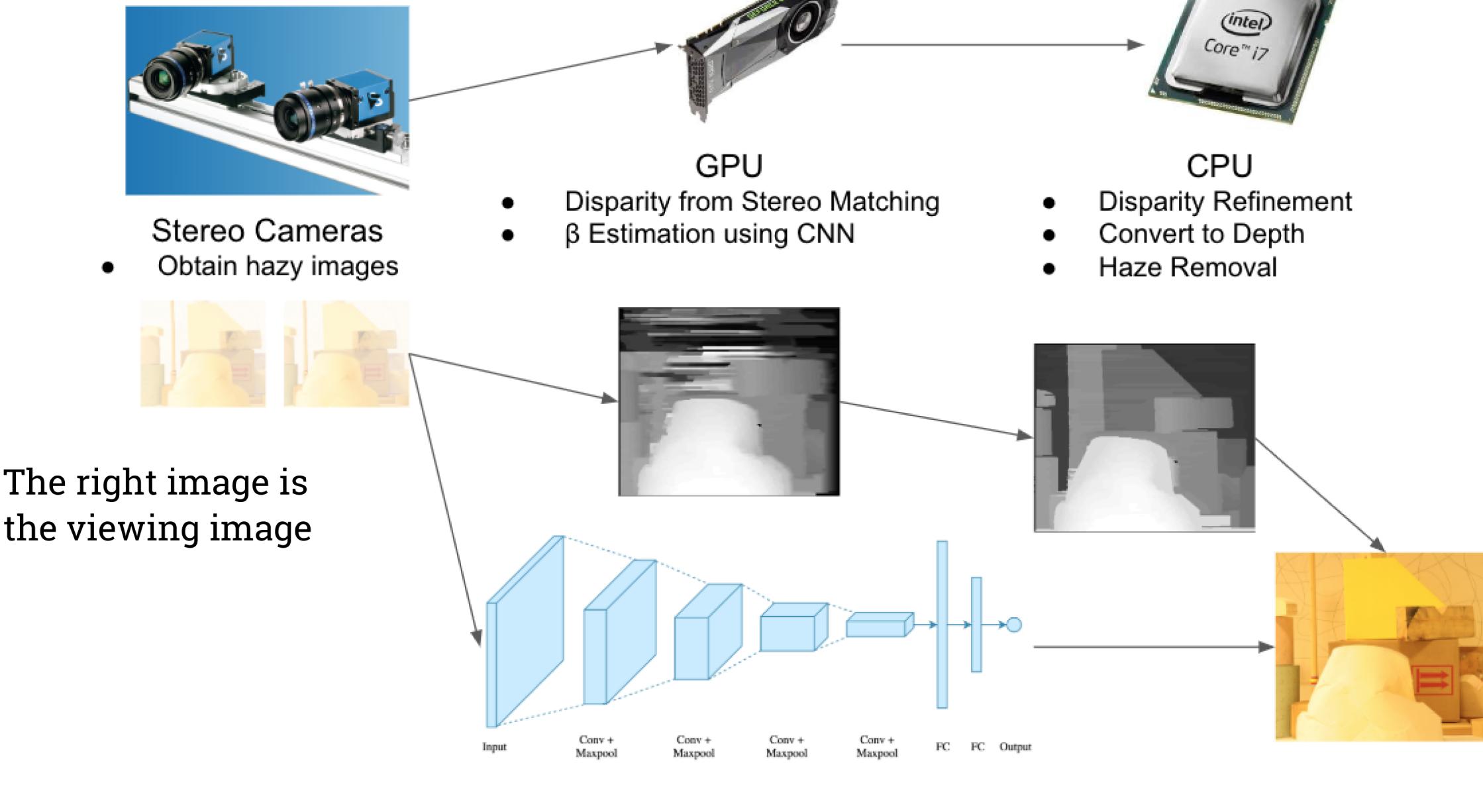
## Estimating $\alpha$

- From atmospheric scattering model,  $E = \alpha$  as transmission approaches 0
- Since all hazy scenes have some amount of direct transmission, we cannot use the atmospheric scattering model equation to find  $\alpha$
- We adopt the method proposed by Cai et al. to determine  $\alpha$ :

$$\alpha = \max_{y \in t(x) \leq t_0} E(y)$$

- Under this rule, we estimate the airlight as the maximum hazy RGB value for pixels that fall below a transmission threshold  $t_0$ . We find that we can set  $t_0 = 255$  without the estimated  $\alpha$  deviating too much from the true value.

## System Architecture



- An Nvidia 1060 Ti 6GB GPU is used for all inherently parallel tasks such as evaluating the regression CNN and calculating the disparity, allowing our system to run in real-time
- Much less expensive and more scalable than current industry solutions, such as the infrared camera

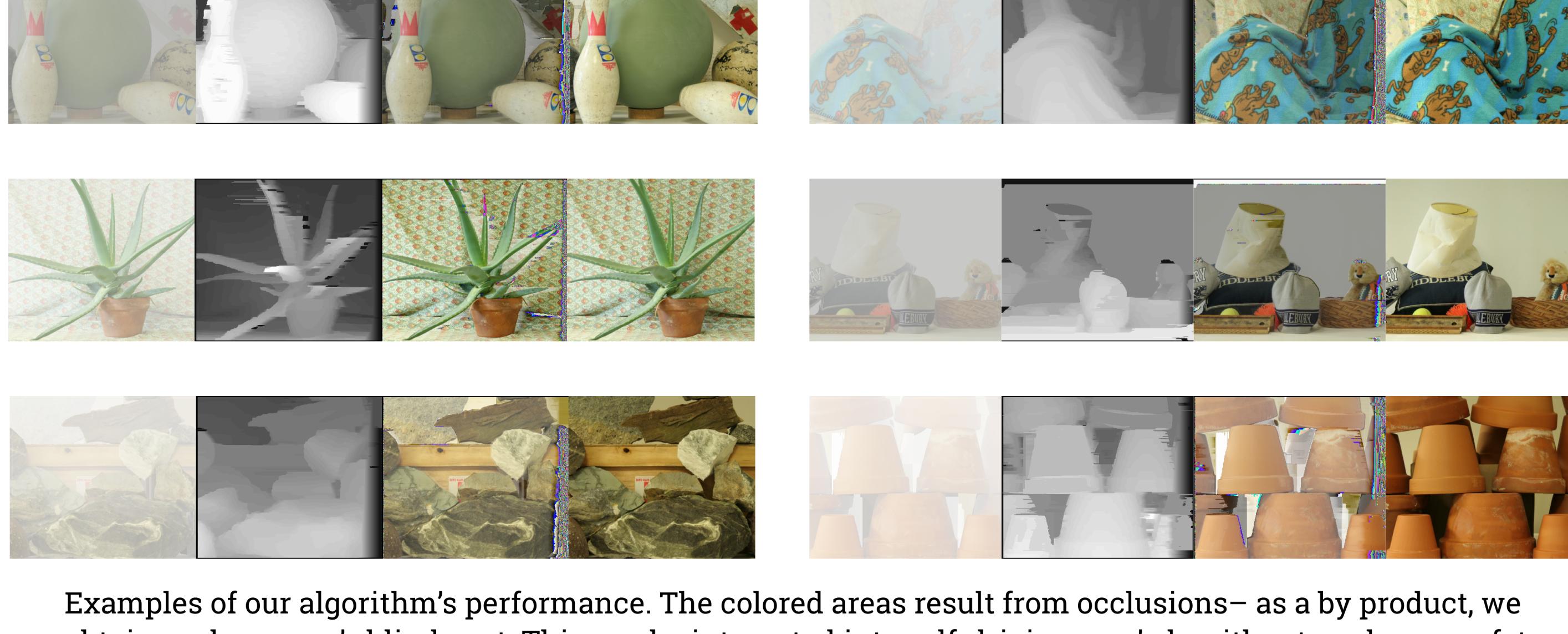
## System Evaluation

- 380 full size synthesized hazy stereo image pairs from Middlebury
- Obtain depth map, estimate  $\alpha$ ,  $\beta$ , and solve for clear image. Measure degradation using Mean Absolute Error and Structural Similarity Index

$$MAE = \frac{1}{n} \sum_{i=1}^n |y_i - \tilde{y}_i| \quad SSIM(x, y) = \frac{(2\mu_x\mu_y + C_1) + (2\sigma_{xy} + C_2)}{(\mu_x^2 + \mu_y^2 + C_1)(\sigma_x^2 + \sigma_y^2 + C_2)}$$

Statistic	Value
Hazy MAE	52.992
Hazy SSIM	0.628
Dehazed MAE	35.545
Dehazed SSIM	0.950

- Greatly improves visibility for autonomous vehicles
- Potentially save many lives and companies millions of dollars
- Exceeds human vision in fog



Examples of our algorithm's performance. The colored areas result from occlusions – as a by product, we obtain each camera's blind spot. This can be integrated into self-driving cars' algorithm to enhance safety.

## Future Work

- **Test dehazing system on existing natural data:** Since most existing natural data is not provided in stereo pairs, we will investigate single-shot depth estimation algorithms.
- **Collect real-life hazy/haze-free stereo data.** Best performed along the Potamic River in the morning/midday.
- **Extend camera system:** Calibrate stereo camera system on a drone/ships/planes and be able process hazy video feed in real-time in a dynamic environment.