Joint Super-Resolution and Optical Flow Estimation

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Outline

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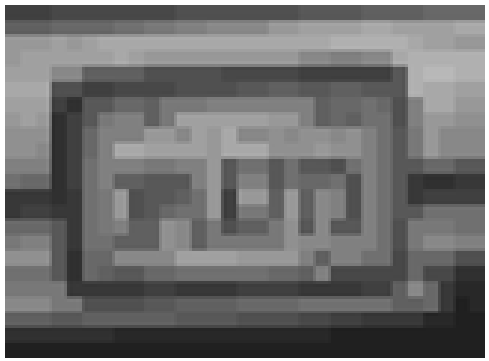
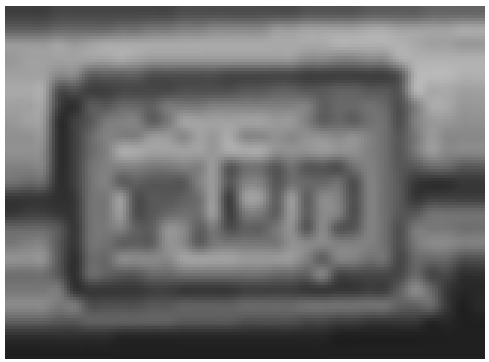
Introduction

- Super-Resolution
  - Enhance resolution of images
  - Gain Additional Details

Introduction

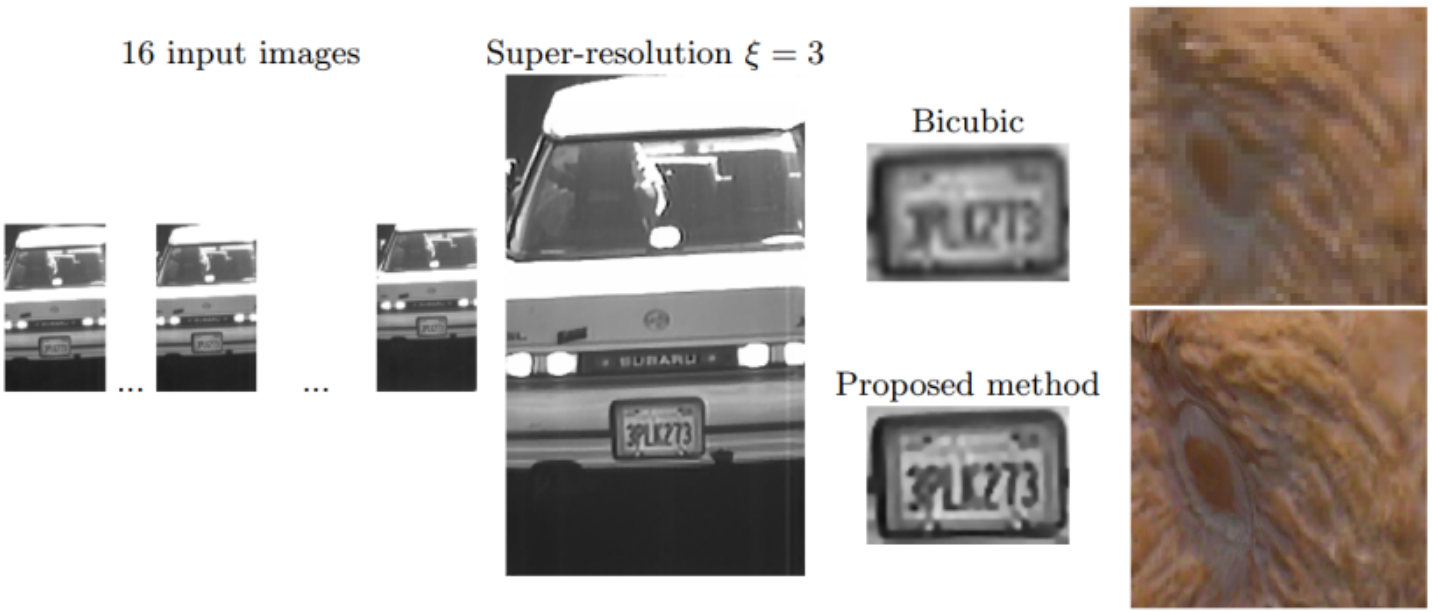
- Super-Resolution
  - Naive Upsampling





Introduction

- Super-Resolution
  - Using multiple images



First image: Unger, Pock, Werlberger, Bischof 2010.
Second image: Goldlücke, Aubry, Kolev, Cremers 2014.

Introduction

- Optical Flow Estimation
  - Estimate the movement in the images

Outline

Energy Minimization Approach

Input Images:

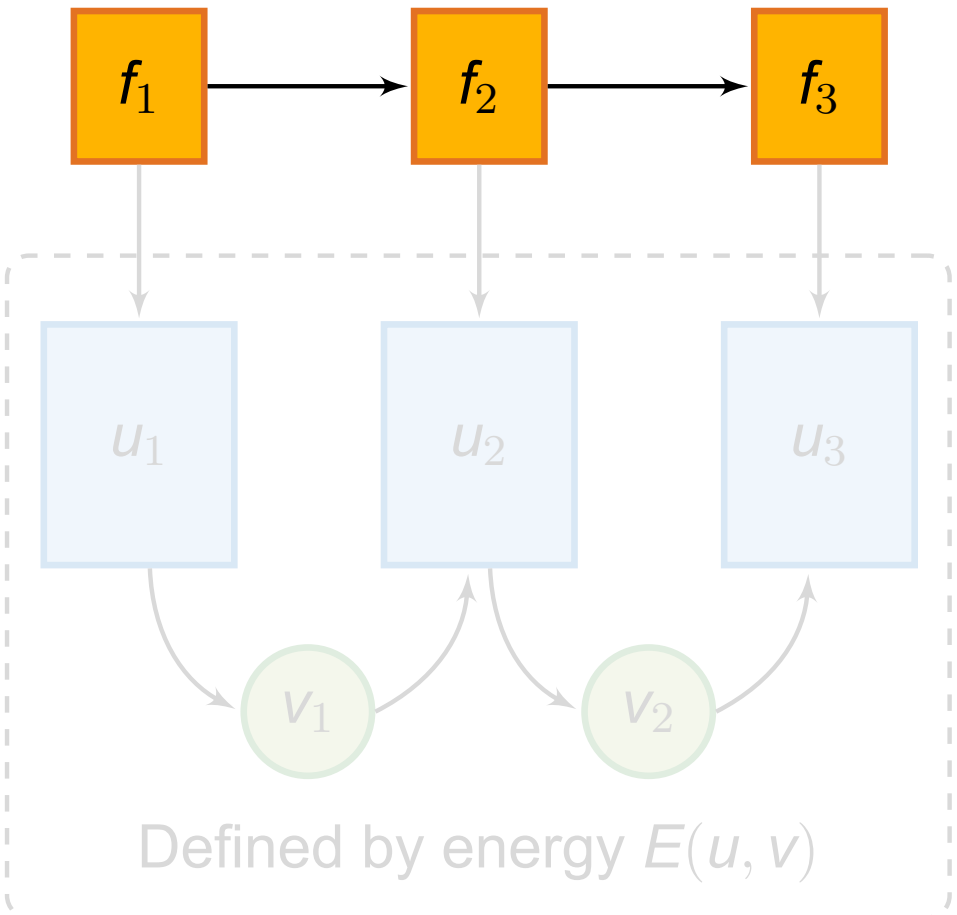
Alternating Optimization:

$$v^{k+1} \leftarrow \underset{v}{\operatorname{argmin}}\, E(u^k, v)$$

$$u^{k+1} \leftarrow \underset{u}{\operatorname{argmin}}\, E(u, v^{k+1})$$

Energy Minimization Approach

Input Images:



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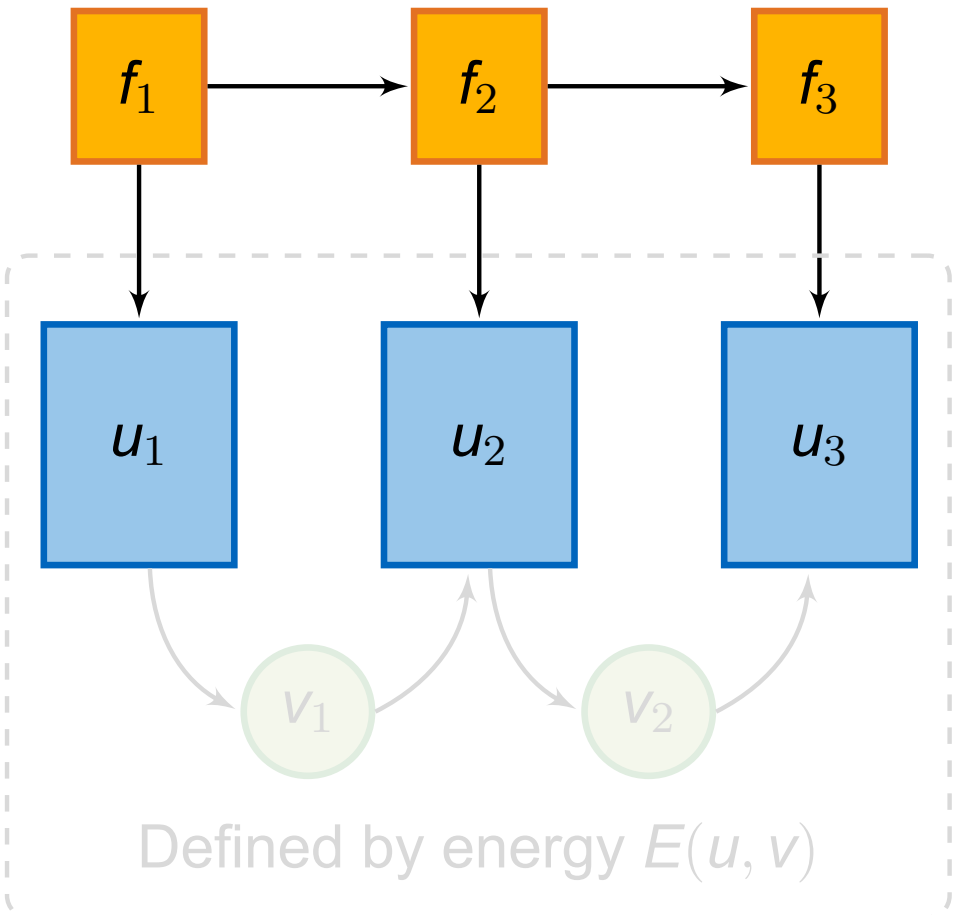

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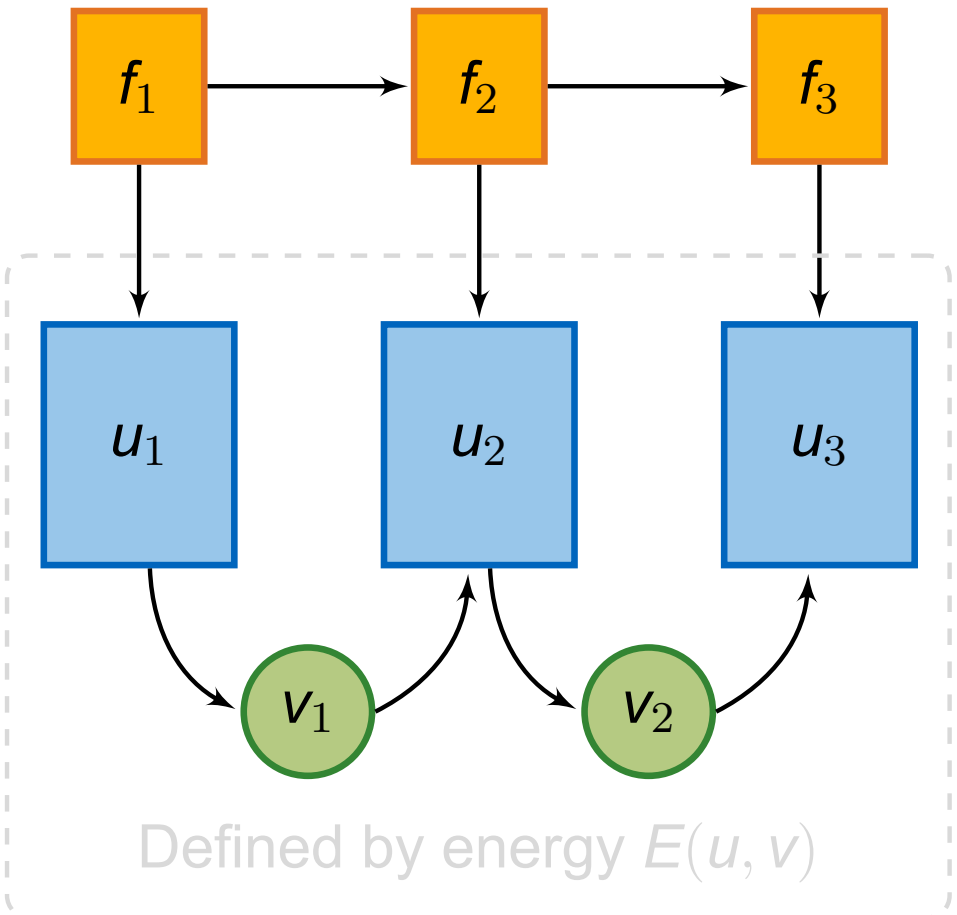

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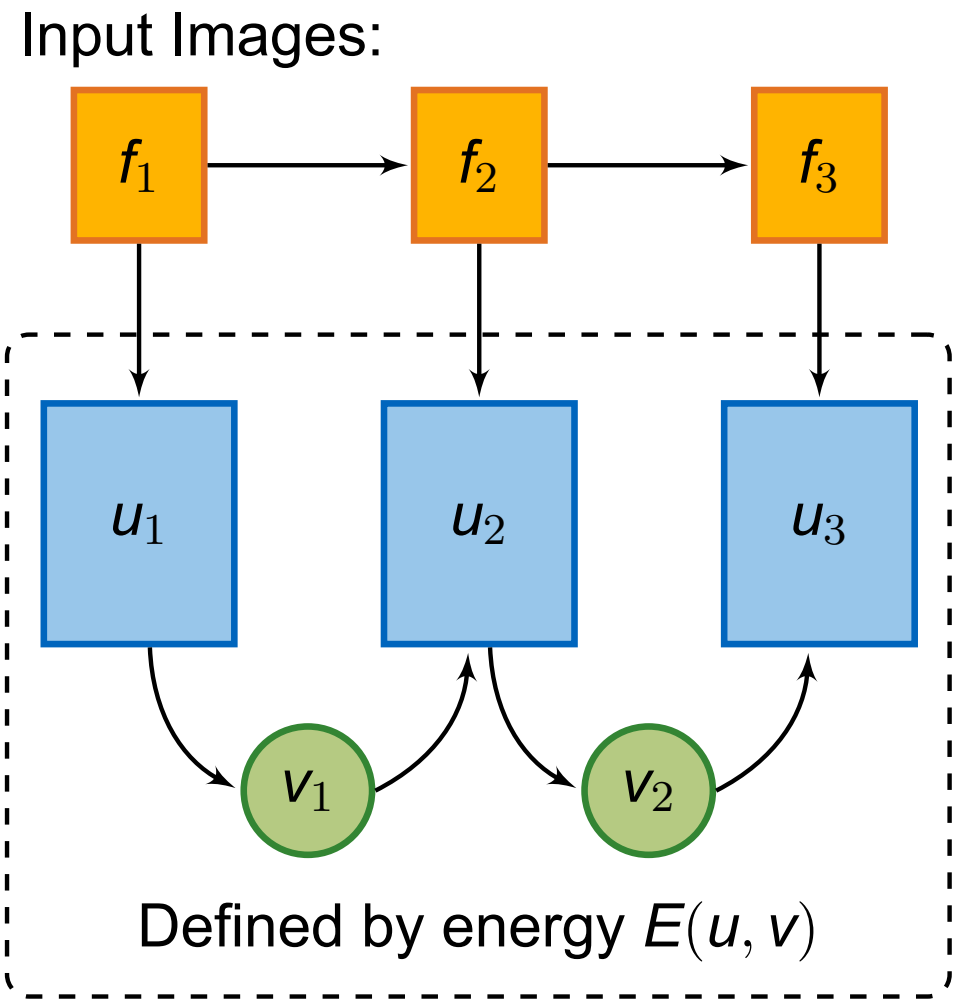

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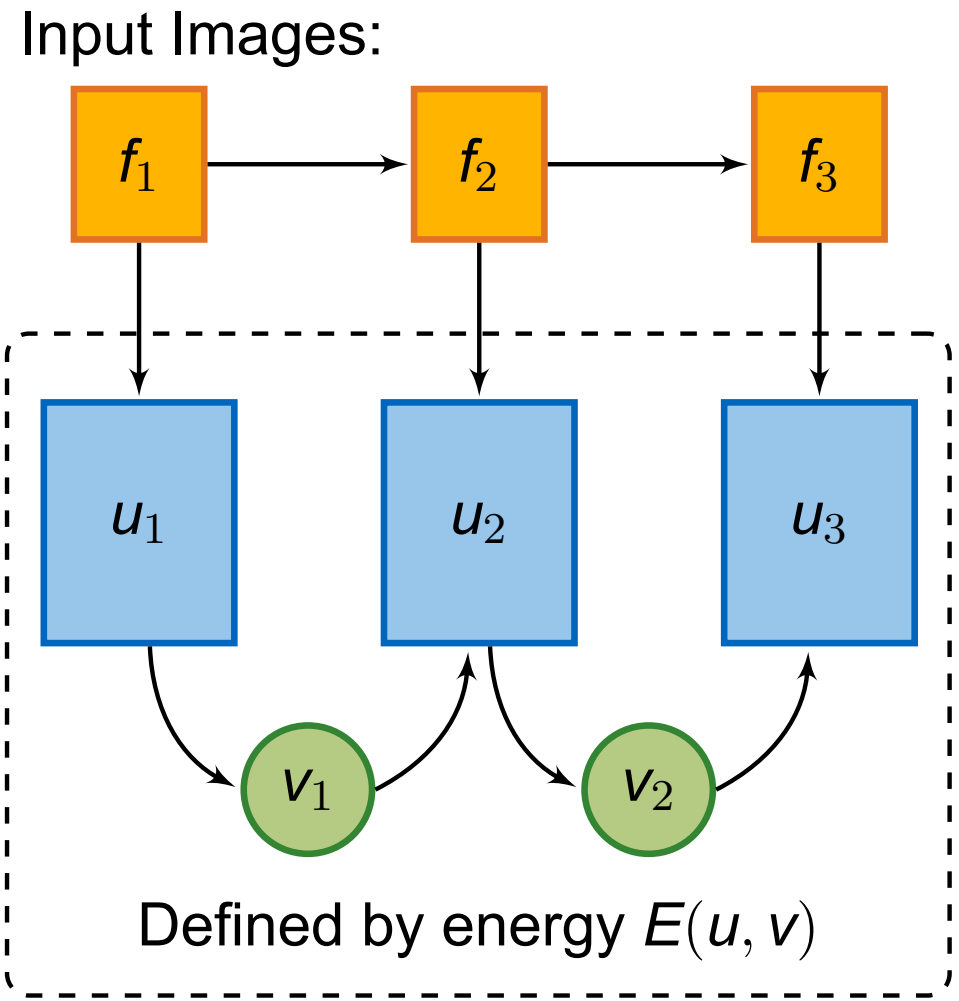

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Flow Field Energy

- Optical Flow Constraint: $u_i(x) \stackrel{!}{=} u_{i+1}(x + v_i(x))$

  $\rightarrow$ minimize $||u_t - \nabla u^T \cdot v||_1$

- Total Variation: $TV(v)$

$$E_{flow}(v) = \gamma||u_t - \nabla u^T \cdot v||_1 + TV(v)$$

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Super-Resolution Energy

- Super-Resolution

  $\rightarrow$ minimize: $||Au - f||_1$

- Optical Flow Contraint

  $\rightarrow$ minimize: $||u_t - \nabla u^T \cdot v||_1$

- Total Variation: $TV(u)$

$$E_{super}(u) = \alpha||Au - f||_1 + \beta TV(u) + \gamma||u_t - \nabla u^T \cdot v||_1$$

Super-Resolution Energy

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Super-Resolution Energy

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Total Energy

$$E_{flow}(v) = \gamma||u_t - \nabla u^T \cdot v||_1 + TV(v)$$

+

$$E_{super}(u) = \alpha||Au - f||_1 + \beta TV(u) + \gamma||u_t - \nabla u^T \cdot v||_1$$

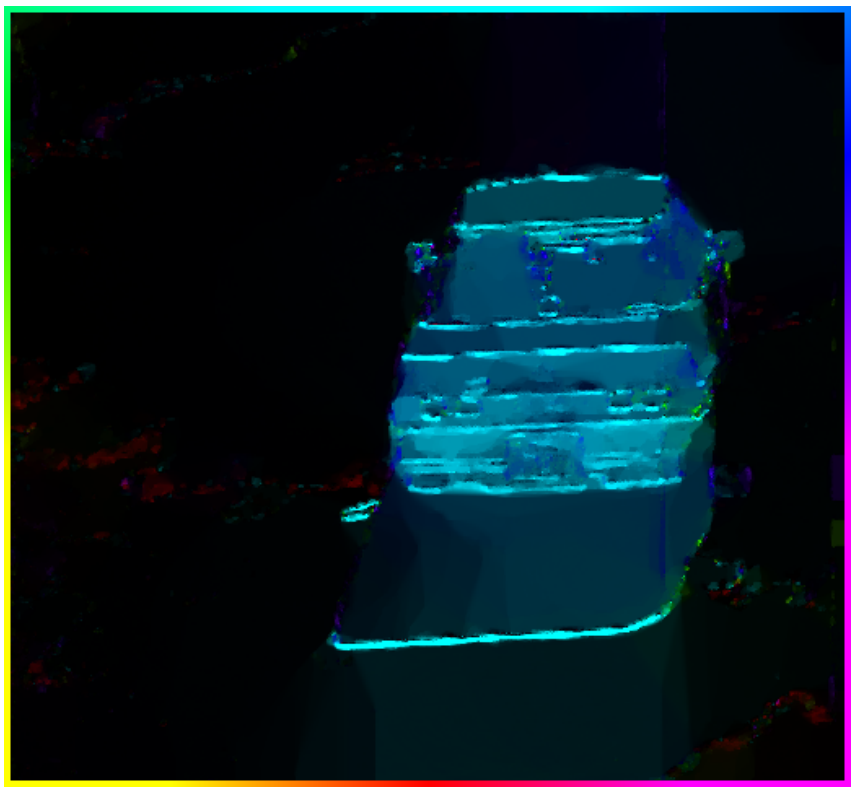
↓

$$E(u,v) = \underbrace{\alpha||Au - f||_1 + \beta TV(u)}_{\text{Super-Resolution}} + \underbrace{TV(v)}_{\text{Flow}} + \underbrace{\gamma||u_t - \nabla u^T \cdot v||_1}_{\text{Coupling}}$$

Outline

Results

- Optical Flow Estimation
  - Live Demo ...



Results

- Super-Resolution with Optical Flow Estimation
  - Input:

Input 1

Input 2

Results

- Super-Resolution with Optical Flow Estimation
  - Result:

Super-Resolution 1

Input 1

Results

- Super-Resolution with Optical Flow Estimation
  - Result:

Super-Resolution 1

Input 1

Results

- Super-Resolution with Optical Flow Estimation
  - Input:

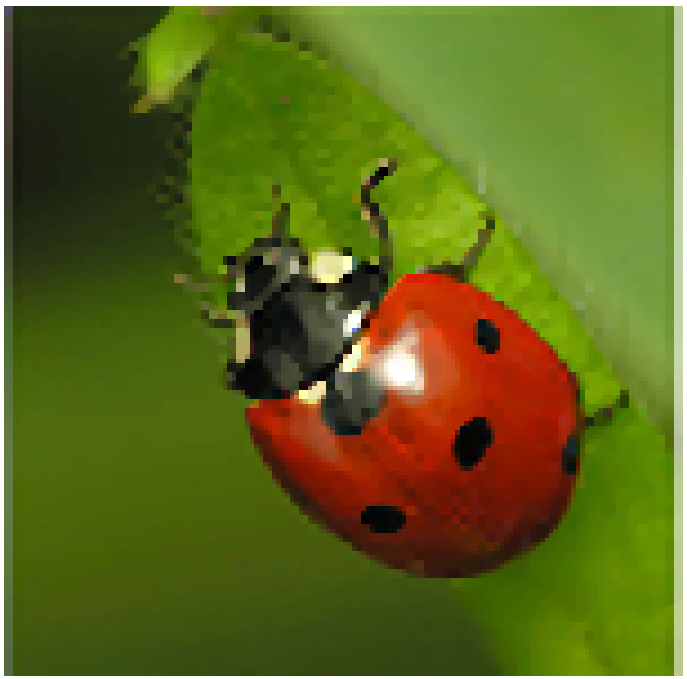
Downscaled

Original

Results

- Super-Resolution with Optical Flow Estimation
  - Result:

2 Input Images



4 Input Images

Outline

Conclusion and Future Work

- Arbitrary scaling
- Optical flow estimation for movements > 1 Pixel

End

Thank you for your attention!