Multi-Resolution Bullet-Time Effect

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1. Bullet-Time

- Capturing multiple-viewpoint images by surrounding cameras.
- Simple switching operation realizes Bullet-Time.

2. Multi-Resolution Bullet-Time

- Zoom-out Bullet-Time (original)
- Zoom-in Bullet-Time

3. Technical Issue

- Simple implementation of zoom-in operation (green rectangle) of multi-view images.

4. Our Approach

4.1. Target point estimation

When the user inputs the new focusing point in Image $I_0$ by zoom-in operation
1. Search the corresponding point of image $I_0$. Use 7 pixel for calculating the SSD (white rectangle).
2. Corresponding point is the point having minimum SSD value.

$E_{ssd}(u_1, v_1) = \sum_{i=3}^{i=3} \sum_{j=3}^{j=3} (I_1(u_1 + i, v_1 + j) - I_0(u_0 + i, v_0 + j))^2$

4.2. Projective transformation

- Homography matrix ($H_m$) realizes
  - Transform the focusing point to the center of image.
  - Adjust the image size after transformation.

$H_m = SA_mR_mR_0^{-1}A_m^{-1}$

- Matrix of intrinsic parameters

$A_m = \begin{bmatrix} f_m & 0 & C_x \\ 0 & f_m & C_y \\ 0 & 0 & 1 \end{bmatrix}$

- Average of focal length

$w_m$: image distance of camera(m)

- Image distance of camera(0) ($C_x, C_y$): image center

$R_m$: Rotation matrix

- Transform the focusing point to the center of image.

$R_m = \begin{bmatrix} e_x' \\ e_y' \\ e_z' \end{bmatrix}$

- New optical axis

5. Experiment

- Photography shooting environment

- Implementation on laptop PC

- Computational Spec.
  - CPU: Intel Corei5 1.70GHz
  - GPU: NVIDIA GeForce GT 620M
  - Memory: 10.0GB RAM
  - Library: OpenCV, OpenGL, GLSL
  - FPS: 60

- Number of cameras: 10
- Resolution of image: 5616pixel x 3744pixel