RGB-D tracking of complex shapes using coarse object models

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Objective: To track complex objects using a RGB-D camera with the help of coarse model

Contribution: 1) Combining point-to-plane distance minimization and photometry for tracking of complex objects using coarse model
2) Using the concept of 'keyframe' in object tracking for increased robustness

Methodology: Joint minimization of two cost functions **:**

1) Point-to-plane distance based cost function
2) Cost function based on difference of direct photometric instensities

(geometric error)

- $\mathbf{e}_i^{dist}({}^n\mathbf{q}_{n-1}) = \left(\left({}^n\mathbf{T}_{n-1}\mathbf{P}_i\right)\cdot\mathbf{n}_k\right) - d_k$

(photometric error)

- $\mathbf{e}_i^{img}\left({}^n\mathbf{q}_p\right) = \mathbf{I_p}\left(\pi\left(\mathbf{P}_i\right)\right) - \mathbf{I_n}\left(\pi\left({}^n\mathbf{T}_p\mathbf{P}_i\right)\right)$

(stacked error)

- $\mathbf{e}_i = \begin{bmatrix}\mathbf{e}_i^{dist}({}^n\mathbf{q}_{n-1}) \\ \mathbf{e}_i^{img}({}^n\mathbf{q}_p)\end{bmatrix}$

(stacked Jacobian)

- $\mathbf{J}_i = \begin{bmatrix}\mathbf{J}_i^{dist} \\ \mathbf{J}_i^{img}\end{bmatrix}$

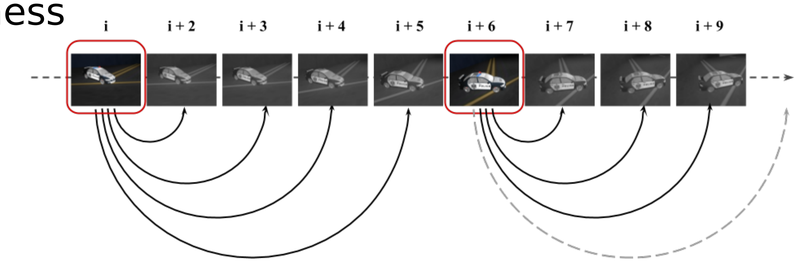
$$\mathbf{J}_i^{dist} = \begin{bmatrix}\mathbf{n}_k^\top & \left(\left[\mathbf{n}_k\right]_\times\mathbf{P}_i\right)^\top\end{bmatrix})$$

$$\mathbf{J}_i^{img} = \begin{bmatrix}\nabla\mathbf{I}_{i,x} & \nabla\mathbf{I}_{i,y}\end{bmatrix}\left(\begin{bmatrix}f_x & 0 \\ 0 & f_y\end{bmatrix}\begin{bmatrix}-\frac{1}{Z} & 0 & \frac{X}{Z^2} & \frac{XY}{Z^2} & -(1+\frac{X^2}{Z^2}) & \frac{Y}{Z} \\ 0 & -\frac{1}{Z} & \frac{Y}{Z^2} & -(1+\frac{Y^2}{Z^2}) & -\frac{XY}{Z^2} & -\frac{X}{Z}\end{bmatrix}\right)$$

(update)

- $\delta\mathbf{q} = -\lambda(\mathbf{WJ})^+\mathbf{We}$

Keyframes:



Results: