Gradient Orientation and Color Based Particle Filter for Complex Visual Tracking

**Research Contents**

**Background**
- Visual object tracking is a challenging computer vision task.
- Problem: Moving Camera
  - Erratic object motion
  - Cluttered Background
  - Occlusion
- The key idea of particle filter is to approximate the required posterior density function by a set of N random samples with associated weights and to compute estimates based on these samples.
- Challenges of tracking with Particle filter:
  - Occlusion caused by similar colored object
  - Long-lived full occlusion

**Proposed Particle Filter**
- **Gradient Orientation & Color Incorporated Observation Model**
  \[
  p_c(x) = \frac{1}{\sum_{j=1}^{M} g(x, y) \delta[h(x') - u]}
  \]
  \[
  p_o(x) = k \sum_{j=1}^{M} g(x, y) G(x, y) \delta[\theta(x, y) - v]
  \]
  \[
  g(x, y) = \frac{1}{\sigma \sqrt{2\pi}} \exp\left(-\frac{1}{4\sigma^2}\left[\frac{(x-c)^2}{w/2} + \frac{(y-r)^2}{h/2}\right]\right)
  \]

- **Multiple State Noises**

**Adaptive State Noises**

\[
B_k^i = b^* \frac{1}{2\pi\sigma_p^2} \exp\left(\frac{(X_{k-1}^i - \hat{X}_{k-1}^i)^2}{2\sigma_p^2}\right)
\]

**Flow Chart**

- Initialization
- Occlusion
- Single state noise based prediction
- Multiple state noises based prediction
  - Color likelihood measurement
  - Orientation likelihood measurement
  - Particle weighting
- Resampling

**Experimental Results**

**Tracking Results**

- Color based PF
- AAMs based PF
- Proposed PF

**Error Comparison**

![Error Comparison Graph]