Image processing for studying size segregation in bedload transport: detection and tracking
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1. Context and objectives

Global aim: studying bedload transport thanks to experiments with two-size beads in a water flow.

Main objective: track beads over long time sequences to better understand size segregation responsible for complex morphology structures.

The idea: propose an online particle filter-based tracking algorithm (framework from [2])
1. Include adapted multiple motion models with known mechanical dynamics to anticipate bead locations.
2. Introduce an observation model from a conditional likelihood to handle detection errors.

Stage 1: Object detector
- Use specific morphological operations (erosion, hconv, cross-correlation...)
- Measure motion states based on neighborhood and velocities
- Return observation state \( S_k = \{x_k^{s1}, x_k^{s2}, \ldots\} \)

Stage 2: Data association
- Perform greedy algorithm on best matching combinations

Stage 3: Particle filtering
Objective: Estimate state \( \theta_k \) of targets according to observations \( z_k \)
1. Prediction: predict target state according to evolution model on particles
   3 motion models based on bedload dynamics:
   - Resting - not moving
   - Rolling - sliding on others
   - Saltating - bouncing on others
2. Correction: correct predicted state thanks to observations
   - Particle importance weighting
   - Normalize weights and resample particles
3. Final target state estimation by averaging resampled particles


4. Example of tracking results

5. Conclusions & Perspectives

- New online particle filter-based tracking algorithm based on multiple dynamic models:
  - Input of object mechanical dynamics helps approaching real trajectories.
  - Allows studying bedload transport with high confidence.

Perspectives: apply to long sequences of sediment transport to study high and lower frequency phenomena

References