Improved Edge Detection using ACS

-Syam Gullipalli

Seminar: Recent Results in Swarm Intelligence
L.079.08005

Edge Detection

- Estimate structural features of image.

- Conventional Methods:

  – Require smoothing.

  – Complex mathematical functions:

    - First and second order derivatives

    - Zero crossing

  – Sensitive to noise.

Ant Colony System (ACS)

$$j = \begin{cases} \arg\max_{j \in N_i^k} (\tau_{ij}^{\alpha} \cdot \eta_{ij}^{\beta}) & \text{if } q \leq q_0 \text{ (Exploitation)} \\ J & \text{otherwise (Exploration)} \end{cases}$$

$$p_{ij}^{(k)}(t) = \frac{[\tau_{ij}(t)]^{\alpha}[\eta_{ij}]^{\beta}}{\sum_{l \in N_i^k} [\tau_{il}(t)]^{\alpha}[\eta_{il}]^{\beta}}$$
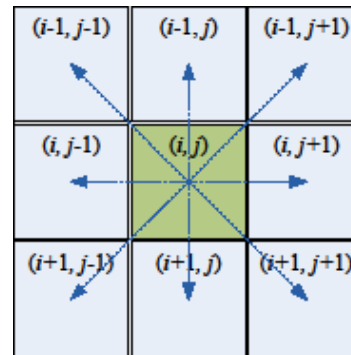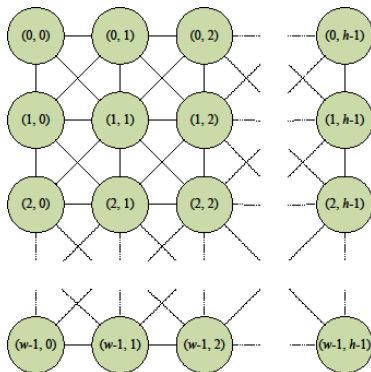
- Two levels of pheromone update:
  - Local
    $$\tau_{ij} \leftarrow (1-\xi)\tau_{ij} + \xi\tau_0$$
  - Global
    $$\tau_{ij} \leftarrow (1-\rho)\tau_{ij} + \rho\Delta\tau_{ij}^{bs}, \forall(i,j) \in T^{bs}$$

Image as Graph

- Represent image as nodes and edges:
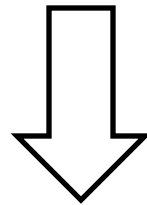

- Heuristc for edge detection:

$$\eta_{ij} = \frac{V_c(I_{ij})}{V_{\max}}$$

$$V_c(I_{(i,j)}) = \left| I_{(i-1,j-1)} - I_{(i+1,j+1)} \right| + \left| I_{(i,j-1)} - I_{(i,j+1)} \right|$$

$$+ \left| I_{(i+1,j-1)} - I_{(i-1,j+1)} \right| + \left| I_{(i+1,j)} - I_{(i-1,j)} \right|$$

Edge Detection using ACS

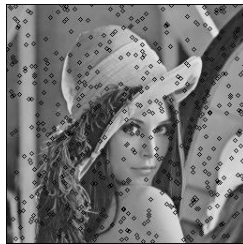- Global pheromone update by all ants, not just by the *best-so-far* ant.

$$\tau_{ij} \leftarrow (1-\rho)\tau_{ij} + \rho\Delta\tau_{ij}^{bs}, \ \forall (i,j) \in \mathrm{T}^{bs}$$

$$\tau_{ij} \leftarrow (1-\rho)\tau_{ij} + \rho\Delta\tau_{ij}^{k}$$
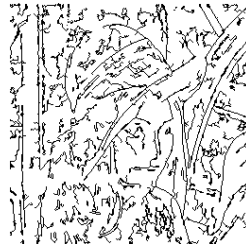
Random Init

- Initialize ants on image using uniform random distribution.

| initialization | iteration 1 | iteration 5 | iteration 7 | iteration 10 |

- Prone to noise.

- Requires thresholding techniques to remove noise.

Initialize on Best Heuristics

- Initialize on best heuristics.
- Best heuristics are the positions where heuristic values are high.

initialization   iteration 1   iteration 5   iteration 7   iteration 10

- No noise filter required.
- Results stagnate after certain iterations.

Re-initialize

- On each iteration re-initialize ants which performed below the average.

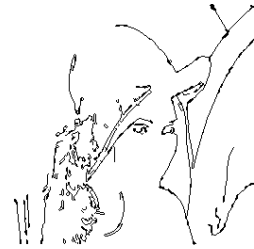- Re-initialize on next best heuristic poasitions.
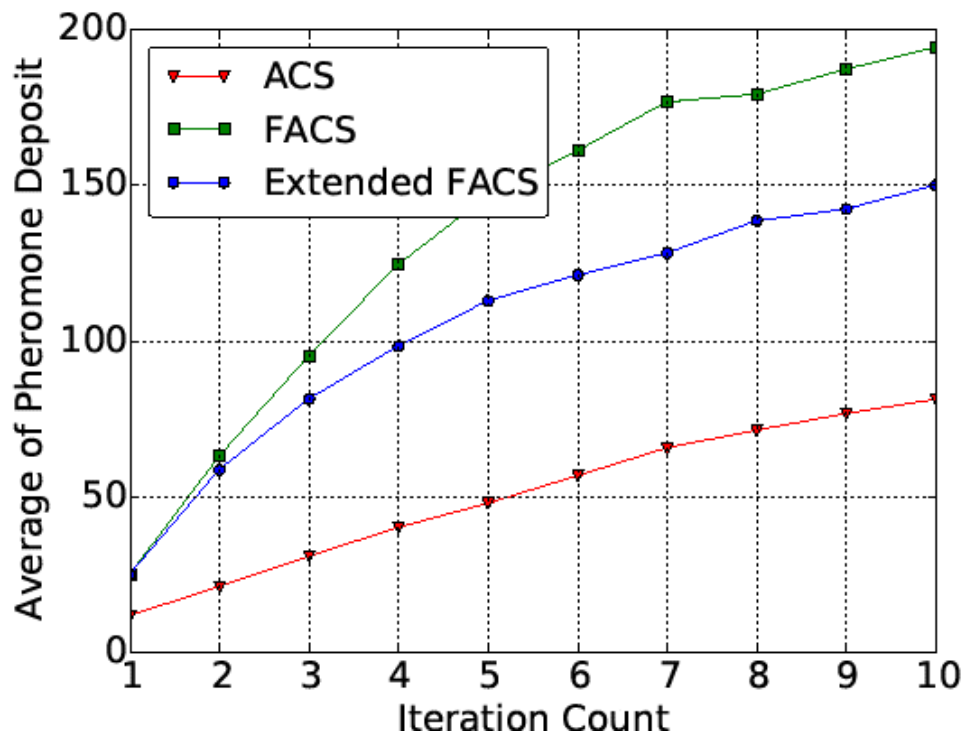

| initialization | iteration 1 | iteration 5 | iteration 7 | iteration 10 |

- No noise filtering required.

- No stagnation of results.

UNIVERSITÄT PADERBORN
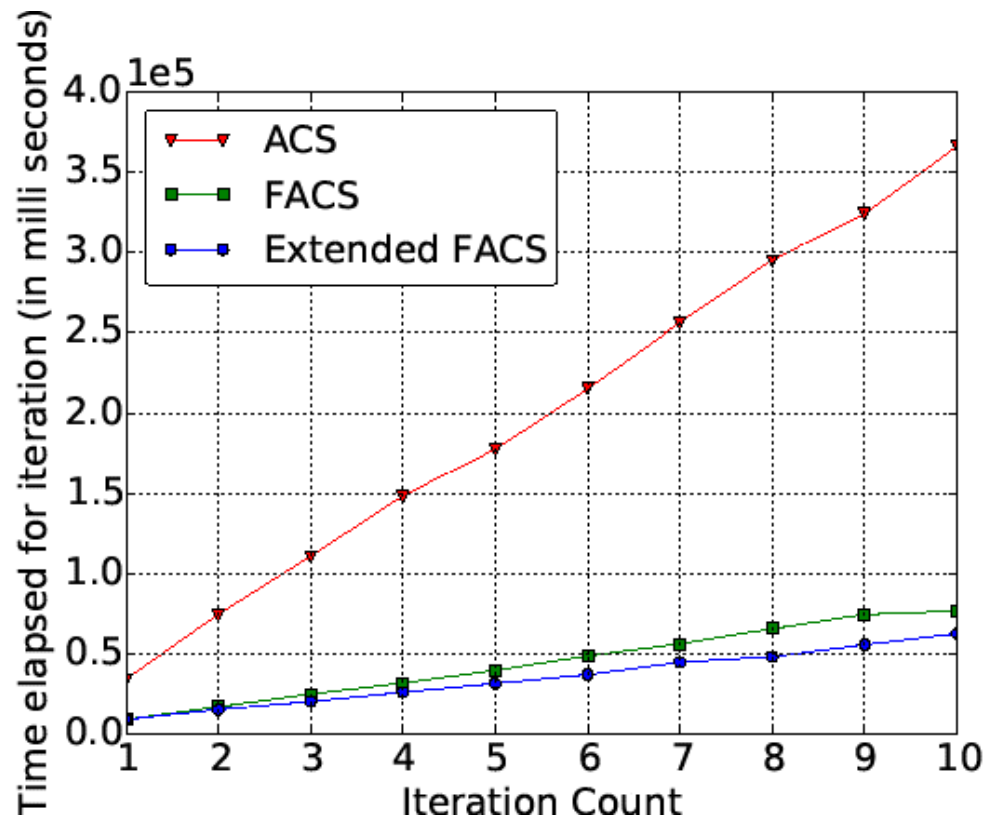Die Universität der Informationsgesellschaft

Comparision(1)

Average Pheromone Deposit

Comparision(2)

Performance

Thank you

UNIVERSITÄT PADERBORN
Die Universität der Informationsgesellschaft