Research Goal:
Evaluate alternative decentralized motion planning schemes for cooperative payload transport by robot collectives within a potential field framework.

Motivations:
- Task might be inherently too complex for a single robot to accomplish.
- Significant overall performance can be achieved by using a group of robots.
- Constructing and delivering of simple-size robots can be easier, cheaper and more flexible and more fault tolerance.
- The constructive, synthetic approach inherent in the in cooperative robots can possible yield insights to the social science (organizational theory, cognitive psychology) and life sciences (theoretical biology, animal anthropology).

Challenges:
- Perform motion planning for a group of robots to a specific target while avoiding obstacles.
- For payload transport, formation maintenance during the course of motion is crucial.

Specific Research Questions:
- Which potential function is suitable for motion planning for group of robot?
- How can we extend the potential framework to help maintain formation?
- How can we further extend this framework to realize the tight formation contact required for cooperative payload transport?

Artificial Potential Field (APF) Approach:

FIRAS Function
Harmonic Function
Ge New Potential

Finding the suitable potential function:
Local minimum problem:

FIRAS Function
Harmonic Function
Ge New Potential

Dynamic Formulation for Group of Robots:
\[ q = v \]
\[ M(q) \dot{q} + V(q, \dot{q}) + G(q) = E(q) u - J^T \lambda \]
\[ J(q) \dot{q} + c C(q) = 0 \]

FIRAS Function
Harmonic Function
Ge New Potential

Results:
- Setup for case study 1
- Simulation result
- Error of each method
- Parameter study
- Setup for case study 1
- Simulation result
- Error of each method
- Parameter study

Conclusion:
We obtained the following general characteristics for the three methods from the case studies:
- Method III > Method I > Method II

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