SIICUSP 25 anos

# Study of robot swarms navigation methods considering an object transportation task

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## OBJECTIVE

A robot team can have better performance than a single robot of high complexity; they can carry objects outstandingly heavier than their own weight and enter hard-to-reach places. Areas of application range from military use to assistance in everyday tasks such as carrying objects on uneven terrain.

With the growth of swarm robotics, multi-robotic systems in which physically simple robots interact with one another to produce emerging behaviors without the need for central control [1], problems arise in controlling such robots. Big swarms of robots with high ability to perform tasks can exhibit complex behaviors that may escape human understanding and control. Thus, we can observe the relevance of studies on swarms that represent part of the future of robotics, with priority in analyzing the performance of the robots while applying different control methods.

The purpose of this project is to study and analyze the performance of swarms of robots on object transportation, in which each robot can push this object to the desired location, considering both the environment and the position of the object unknown.

The transport of objects is a fundamental and recurring task in robotics. Using multiple robots, there is the advantage of low cost of production compared to building a single more complex robot. The focus is to study multi-robotic systems in which the agent has minimum sensing and communication requirements, and is able to manipulate objects by just pushing them.

Currently, the task on this scale is performed by applying external fields, such as magnetic fields; Manipulation by micro-tweezers and surrounding an object with a swarm of agents. In this proposal, will be used the Granular Convection transportation method, which is based on Brazil Nut Effect, but instead of acting by gravity or external forces, the granular convection is done by self-propelled robots, which can be guided by the application of an external field[2].

## MATERIALS AND METHODS

O projeto foi simulado na biblioteca multimídia para *python PyGame* [3], utilizando uma interface gráfica amigável ao usuário com controle por mouse e setas do teclado. A interface foi inspirada na aplicação de Becker et al.[4], que fizeram jogos de controle de enxames para realizar tarefas para navegador

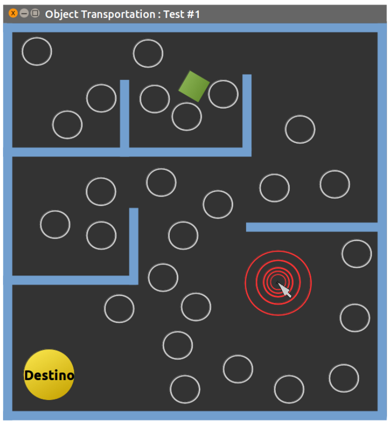



Fig. 1. Modelo de aplicação do Projeto

analisando os dados fornecidos em cada jogo realizado para entender melhor o comportamento de enxames.

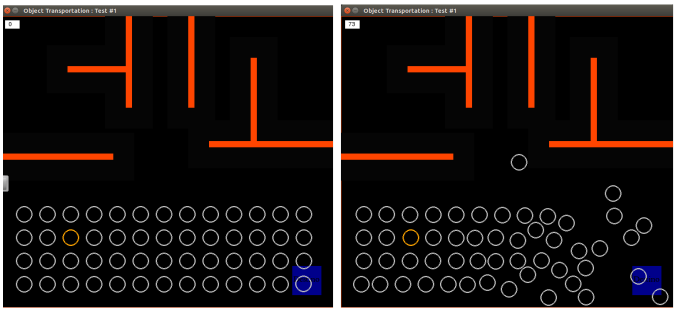
Simulando um enxame de robôs descentralizado atuando em um ambiente virtual, os robôs autonomamente realizam a tarefa designada. Cada um destes robôs terá seu próprio raio de comunicação e de sensoriamento.

A tarefa que o enxame deve cumprir é a de e transporte de objetos passivos. Este transporte irá envolver o algoritmo de convecção granular: quando o objeto for encontrado, o agente irá informar os agentes em seu raio de comunicação para que, juntos, tentem mover o objeto através da convecção granular. O objeto será empurrado a partir da aplicação de forças repulsivas cuja intensidade aumentará com a proximidade de cada robô.

Será feita a comparação do método original com a adição de três regras diferentes: Regra de cobertura de área do *SLACS*; Regra de deslocamento por campos potenciais; Regra de navegação em grupo coerente com multiagentes recíprocos e comportamento de proximidade.

Para podermos mesclar os métodos, tendo em vista que todos funcionam colocando uma força ou velocidade pra o agente se mover na direção desejada, as velocidades resultantes de cada método, considerando a direção, serão multiplicadas por constantes diferentes e depois somadas.

Para sabermos o desempenho de cada algoritmo será feita a comparação considerando as seguintes métricas : duração da realização das tarefas (localizar e transportar), número de colisões entre agentes durante a navegação, número de agentes



e tamanho diametral dos agentes e raio de comunicação.

## Results

There has been made the following activities on the first semester of 2017 , aiming to achieve the proposed objectives:

### A. *Literature review*

The student dedicated a period to find articles about multi-robotic systems of area coverage, potencial fields theory, proxemic group behavior and other object transport systems.

### B. *Experiments of movements techniques*

The physical part of repulsion and collision with the objects and walls was implemented. To make the repulsion with the walls of the labyrinth, a repulsion force was used on the four sides of each wall with a prefixed range of influence. There were difficulties with the implementation because there was repulsion force with rectangles and not with points. In order to calculate the force on the edges it was used the vector treatment addressed in Appendix I of Khatib article [5]

### C. *Implementation of robot movement and transport strategies*

In order to verify if the strategies developed actually perform the task of movement and area coverage and to measure the performance, several tests must be made between the strategies, the Potential Fields strategy, without the application of the object transport task, the strategy of *SLACS* and the Proxemic Group Behavior strategy to quickly move around and avoid getting stuck in corners.
Currently the strategy of potential fields with granular convection has been implemented, applying repulsive forces to obstacles and to the goal. With the exception of the object that has to be transport to the destination, to which a repulsive force has not been applied to the destination. The result was observed in Figure 2.

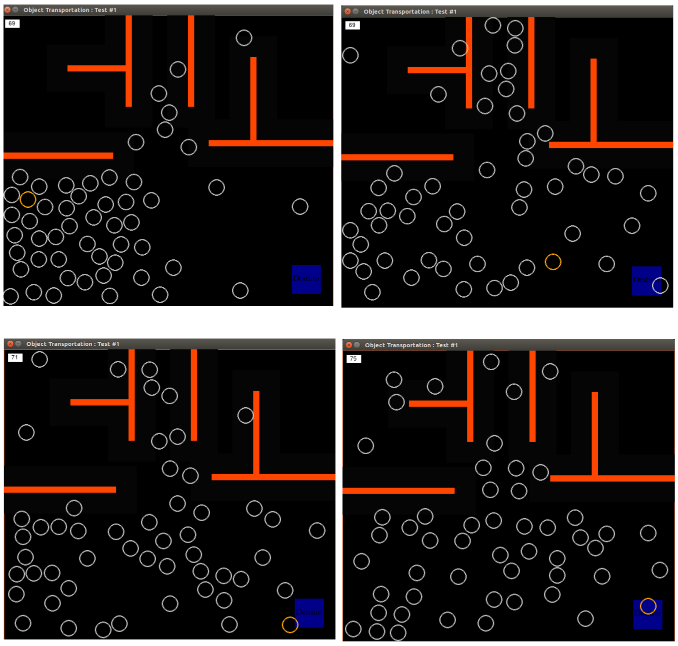


Fig. 2. Granular Convection simulation

## Conclusion

## References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