Traffic Flows and Evacuations in Robotic Systems: an experimental exploration

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This research work presents an experimental study of traffic flows in a single line circular road using line-follower robots. Inspired by the Nagel-Schreckenberg model [1], the study aims to reproduce its key elements and explore the emergent behavior of the system of robots.

The experimental setup consists of a circular track with line-following robots capable of autonomous movement (Fig. 1). Robots are programmed to mimic the behavior of vehicles in a traffic system, incorporating features such as obstacle detection, braking and acceleration. By varying parameters such as robot density and maximum speed, we investigate the dynamics of traffic flow and the occurrence of phase transitions between free-flowing and congested traffic states. Through extensive data collection and analysis, various macroscopic observables, including traffic density, average velocity, and flow rate, are measured and compared with theoretical predictions from the Nagel-Schreckenberg model.

The results shed light on the system's collective behavior, highlighting the impact of density on traffic congestion, the role of fluctuations in traffic flow, and the influence of interactions on overall traffic performance.

In addition to studying traffic flows on the circular road, the research aims to explore the robots' behavior in evacuation scenarios through a narrow exit, both competitively and cooperatively. The findings contribute to our understanding of collective movement and decision-making processes in complex systems, with implications for various fields, including transportation planning, swarm robotics, and crowd management.

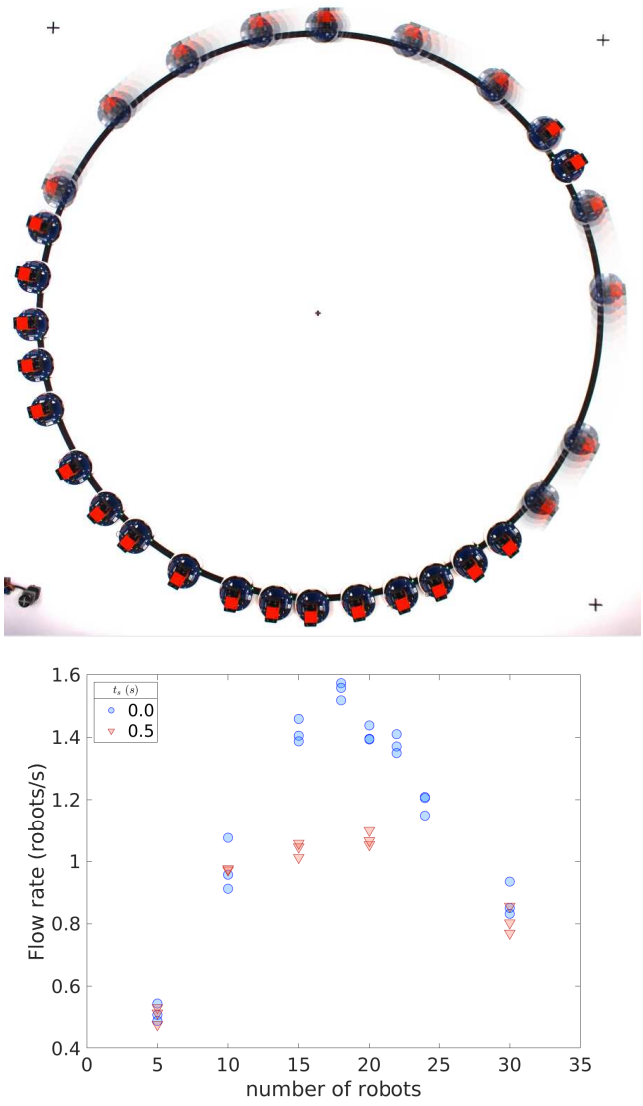

Fig. 1. (a) Top view of the circular road. Image shows a 15-frame overlay (0.75s) of an experiment with 30 robots. (b) Flow rate vs. number of robots for different stopping times t_s, i. e., time that robots wait after an obstacle detection.

[1] K. Nagel and M. Schreckenberg *A cellular automaton model for freeway traffic*, J. Phys. I France. **2**, 2221 (1992).