Institut de Robòtica
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Robot-person accompaniment simulator tutorial (ASP-SI): Conceptual view

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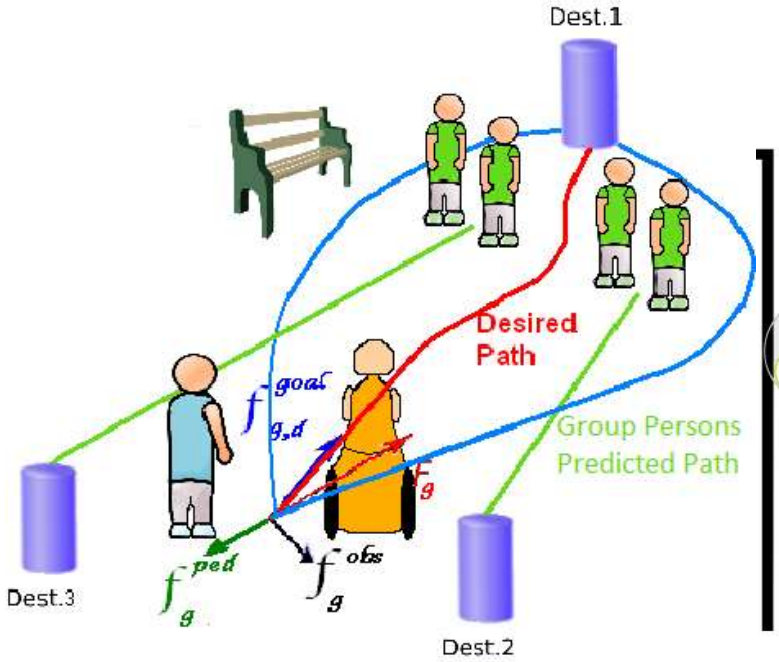
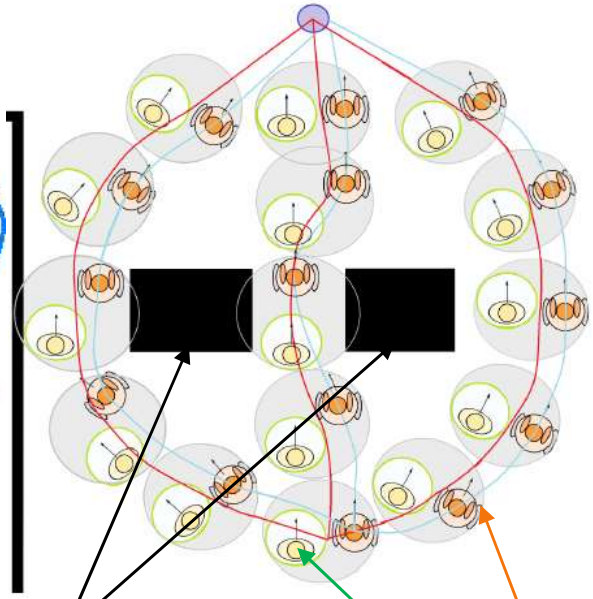
Main Objective

The aims of this robot-person accompaniment simulator is to provide a tool to simulate the navigation of both the robot and the person in dynamic urban environments. In this accompaniment task, both agents are able to navigate avoiding static and moving obstacles while the robot is accompanying a person.

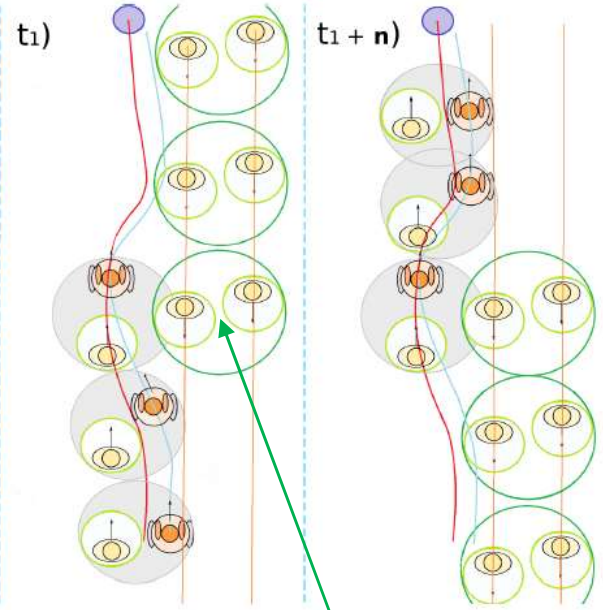
The modelling is based on Social Force Model



The model allows to change the accompaniment robot-person configuration



The model allows to change navigation behavior due to other pedestrian's movements



Publications where this work is described

- **Adaptive Social Planner using a Side-by-side Individual accompaniment (ASP-SI): Repiso et al. IROS 2017**
- **ASP-SI joined with people approaching method: Repiso et al. Robot 2017, IROS 2018 and IJSR 2019**
- **ASP-SI joined with a group of people accompaniment (ASP-VG & ASP-SG): Repiso et al. IROS 2019 and ICRA 2020 with RA-L**

Motivation: Looking to help people in everyday tasks

We expect to see social robots sharing our urban areas

Tokyo, Shibuya cross

Toulouse, Christmas Market

Both videos/Images have been recorded by Ely Repiso.

Motivation: Looking to help people in everyday tasks

Accompanying people

Autonomous wheelchair

http://inventorspot.com/articles/robotic_wheelchair_will_even_heel_your_dog

Go shopping

http://www.robot.soc.i.kyoto-u.ac.jp/en/research/

Carry baggage

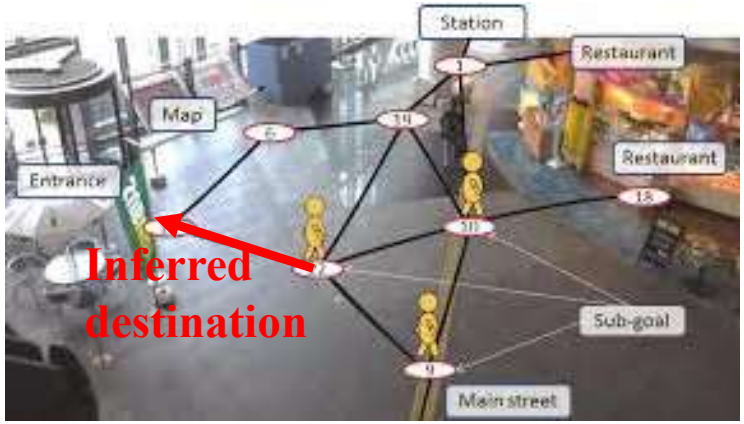
http://www.canalsur.es/la-aerolinea-nipona-jal-prueba-un-robot-que-ayuda-a-transportar-el-equipaje/1166498.html

People Social Behavior

People Simulation: Individual or groups

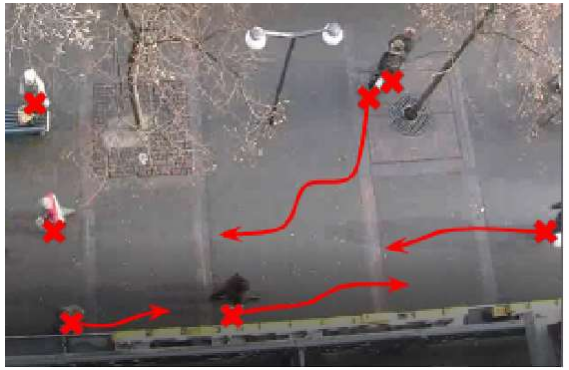
Boes, Jérémy, Cédric Sanza, and Stéphane Sanchez. "Intuitive method for pedestrians in virtual environments." *ICG2011*.

Infer People's or Group Destinations



Ikeda, Tetsushi, et al. "Modeling and prediction of pedestrian behavior based on the sub-goal concept." *Robotics* 10 (2013)

Predict People's Behavior

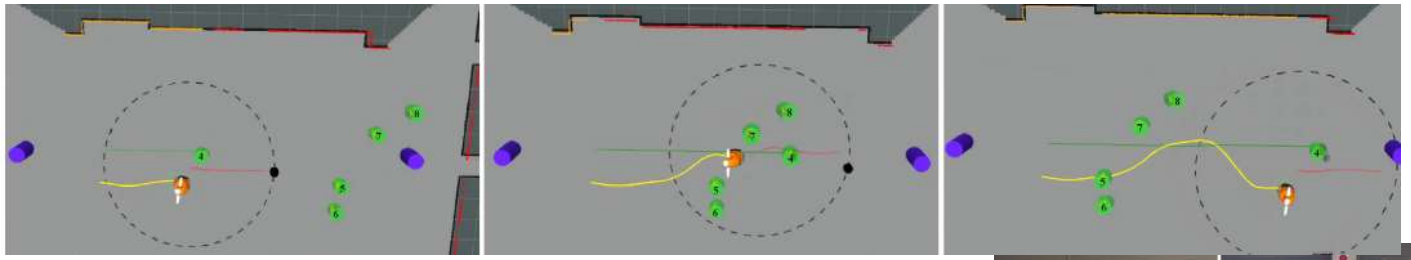


Wang, Allan, Zirui Wang, and Wentao Yuan. "Pedestrian trajectory prediction with graph neural networks." *Semantic Scholar* (2019).

Functionalities of the system

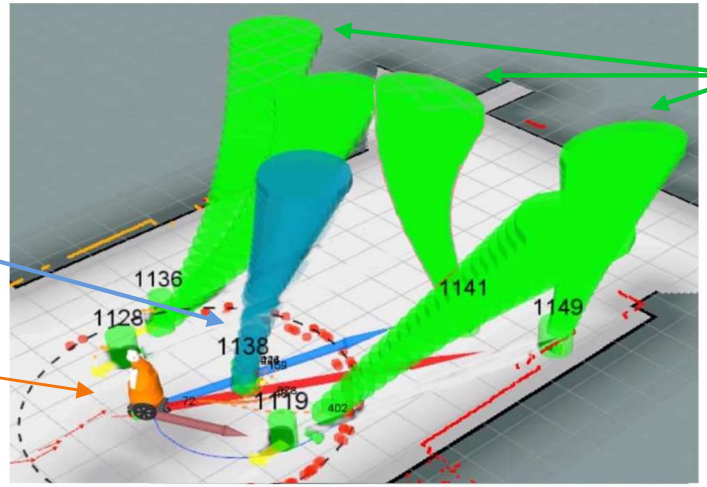
The complete system includes the next systems and subsystems with different functionalities.

1. **Robot-Person Accompaniment (ASP-SI)**: The aim is to accompany people in urban areas.



Publications of this method:
- The same described in the main page.

2. **People prediction and Infer people destinations**: The objective is to predict pedestrian's future paths



Prediction of the accompanied person

Robot

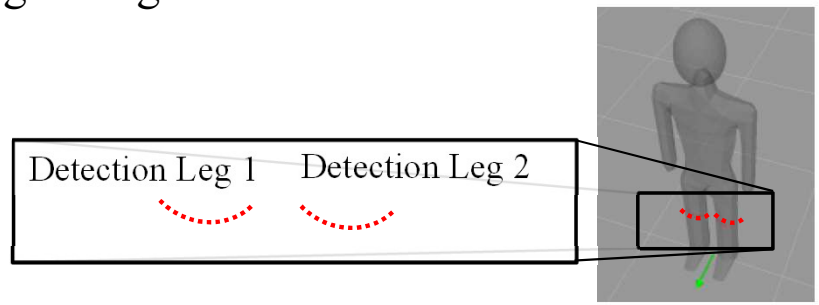
Prediction of pedestrian's movement

Publications of this method:
- G. Ferrer and A. Sanfeliu. ICRA 2014.
- G. Ferrer and A. Sanfeliu. PR-L 2014.

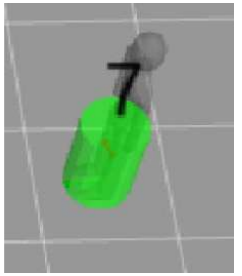
Functionalities of the system

3. **People leg detection**: The objective is to detect people's legs using a 2D Lidar.

Publications of this method:
- K, Arras, et al. ICRA 2007.
- Herrero Cotarelo, F. (2012). Detección automática de personas mediante láser 2D y su aplicación a la robótica de servicios.



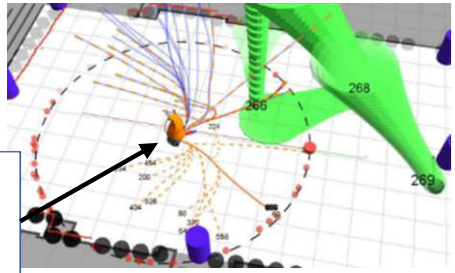
4. **People tracking**: The aim is to track objects using a 2D Lidar. It tracks the detections of the people's legs. These detections are 2D points.



Publications of this method:
- V. Vaquero, et al. Sensors 2019.
- REPISO POLO, Ely. *Robust multi-hypothesis tracker fusing diverse sensor information*. 2015. Master's Thesis. UPC.

Other functionalities

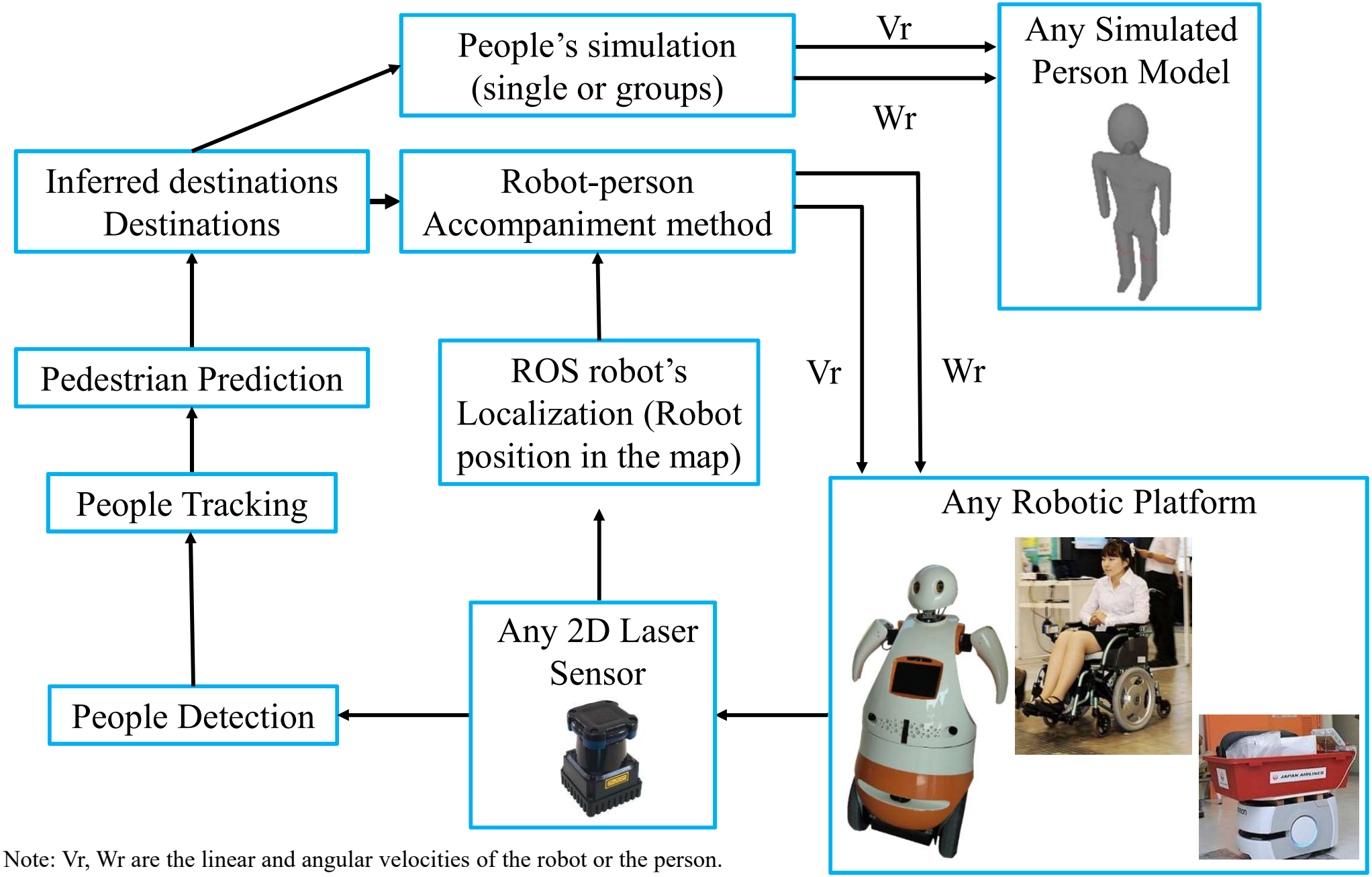
5. **People simulation (individual or group of two)**: The system can be used for moving only the people.



Using here a person model and moving this person model with our system

Publications of this method:
- The same described in the main page

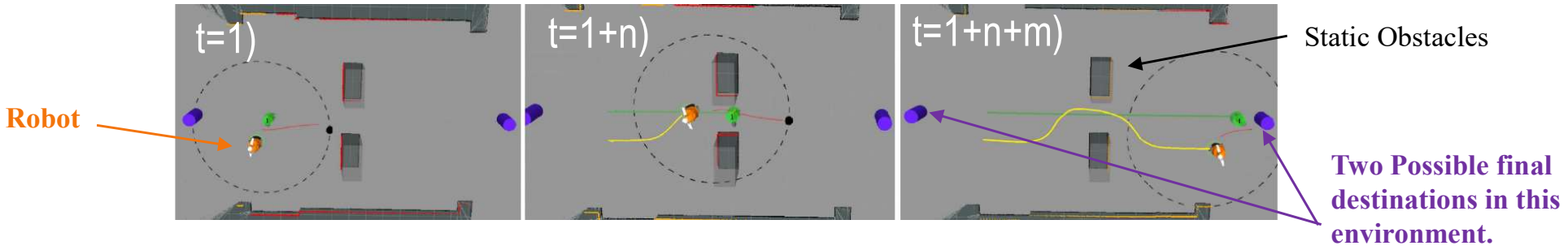
System structure (Including functionalities)



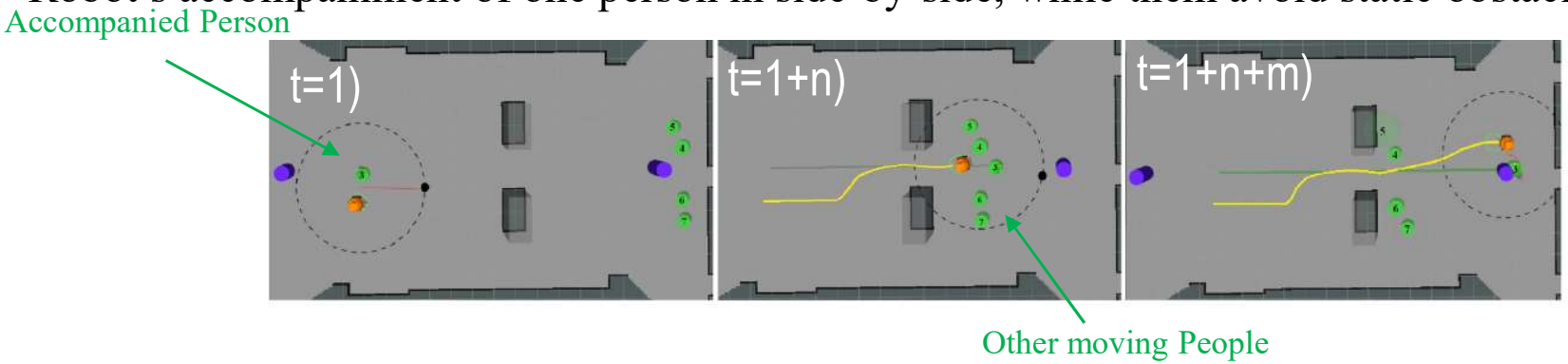
Note: Vr, Wr are the linear and angular velocities of the robot or the person.

Examples of Simulation Experiments

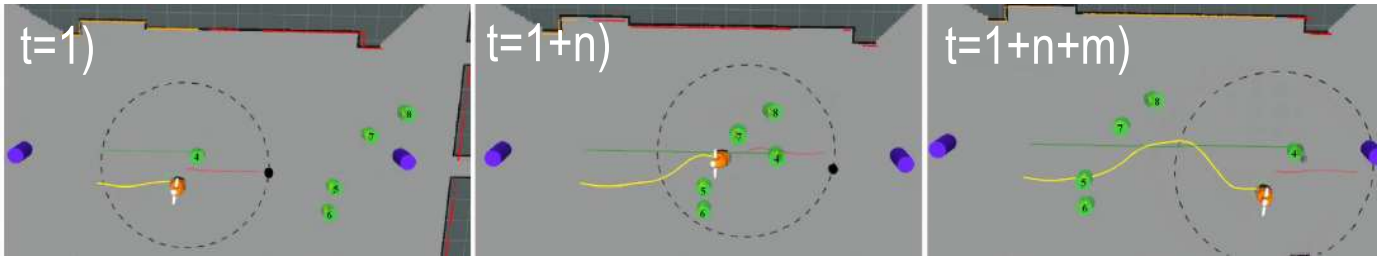
Robot's accompaniment of one person in side-by-side formation, while them avoid static obstacles.



Robot's accompaniment of one person in side-by-side, while them avoid static obstacles and other people.



Robot's accompaniment of one person in side-by-side, while them avoid other moving people.



Examples of Real-life Experiments based on simulations

From simulation to real-life experiments:

Whatever you simulate, you can directly translate to real-life experiments because we use ROS (Robot Operating System), however you have to take into account that the simulator models could be that they do not exactly match real-life robot and human's models.

Avoiding static obstacles	
Avoiding moving people	
Avoiding moving people and static obstacles	

Note: All real-life videos of this Robot-person accompaniment method are here: http://www.iri.upc.edu/people/erepiso/IROS2017.html

For more details see

1. To Extend the conceptual view:

- ASP-SI_Conceptual_view_HD_video.mp4

2. Installation and Launch:

- ASP-SI_Tutorial_Docker_Install_and_Launch_Document.pdf
- ASP-SI_Tutorial_install_and_launch_docher_HD_video.mp4

3. Software Capabilities:

- ASP-SI_Tutorial_Capabilities_Document.pdf
- ASP-SI_Tutorial_Capabilities_HD_video.mp4 (Not included, because it is enough with the pdf)

4. Theoretical view of the method:

Paper publications of this method:

- **Adaptive Social Planner using a Side-by-side Individual accompaniment (ASP-SI): Repiso et al. IROS 2017**
- **ASP-SI joined with people approaching method: Repiso et al. Robot 2017, IROS 2018 and IJSR 2019**
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