Mobility Assistance

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Navigation of a **wheelchair** taking into account the **context of use :** main challenges

- **Study of the needs** : who might benefit from an Autonomous Wheelchair?
- The wheelchair is a robot **: autonomous navigation**
  - **Uncertain and incomplete knowledge** of the environment
  - **Ability to predict** the behavior of the obstacles (which can be humans)
- The wheelchair **transports a person**
  - Person/wheelchair **communication**
  - Integration **of social conventions** in the navigation decision
  - **Autonomous/Semi-autonomous** navigation
- **Validation** of the proposed system

Scientific challenges

- The **static environment** is unknown

⇒ *Construction of maps of the environment*

- **Mobile obstacles** are not known, but they follow typical patterns

⇒ *Detection & Tracking + Prediction on-line*

⇒ *Learning of typical patterns*

- Deal with **populated, dynamic and uncertain environments**

⇒ *Navigation decisions based on a risk criteria (Risk-RRT Fulgenzi 08)*

$P_{coll}(q)$: risk of collision of $q = (s, t)$, state s at time t

Static Obstacle "contribution" Moving Obstacles "contributions"

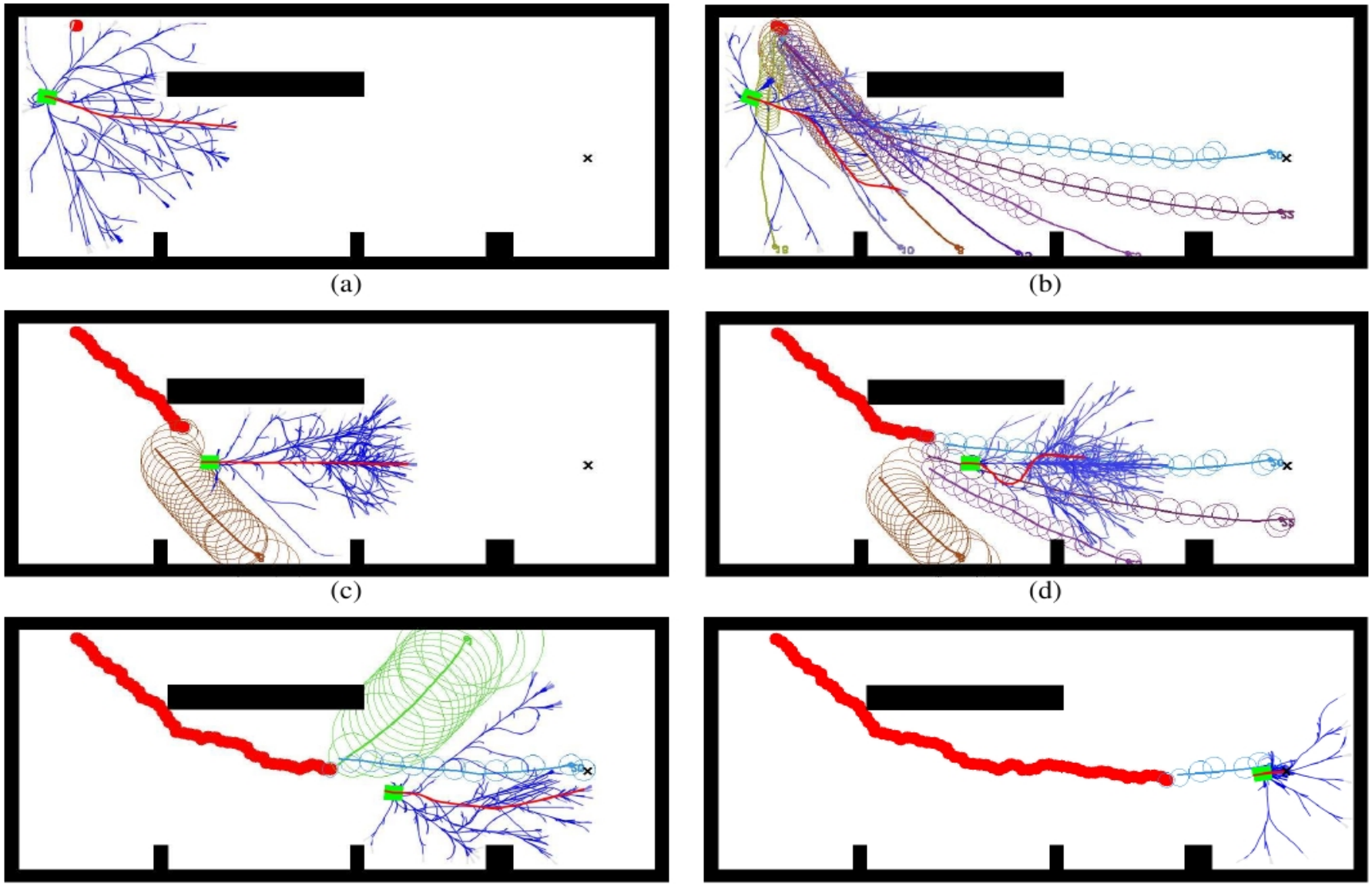
$$P_{coll}(q) = P_{cs}(s) + (1 - P_{cs}(s)) \cdot P_{cd}(s, t) =$$

⇒ *Social conventions with proxemics constraints (Personal Space, Interaction) (Rios 2011)*

Fulgenzi C., Tay C., **Spalanzani A.,** Laugier C. "*Probabilistic navigation in dynamic environment using Rapidly-exploring Random Trees and Gaussian Processes*", IEEE/RSJ 2008 International Conference on Intelligent RObots and Systems, 2008

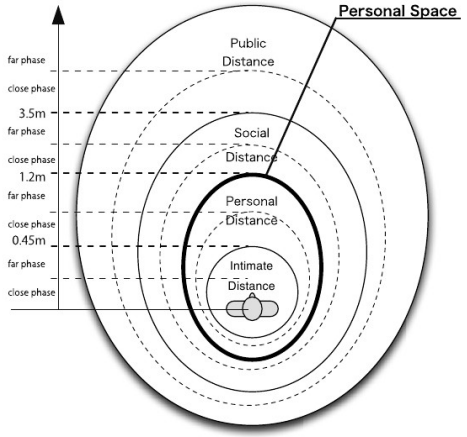
Rios-Martinez, J., Spalanzani, A., Laugier, C.: Probabilistic autonomous navigation using risk-rrt approach and models of human interaction. In: Proceedings of the 2011 IEEE/RSJ International Conference on Intelligent Robots and Systems (2011)

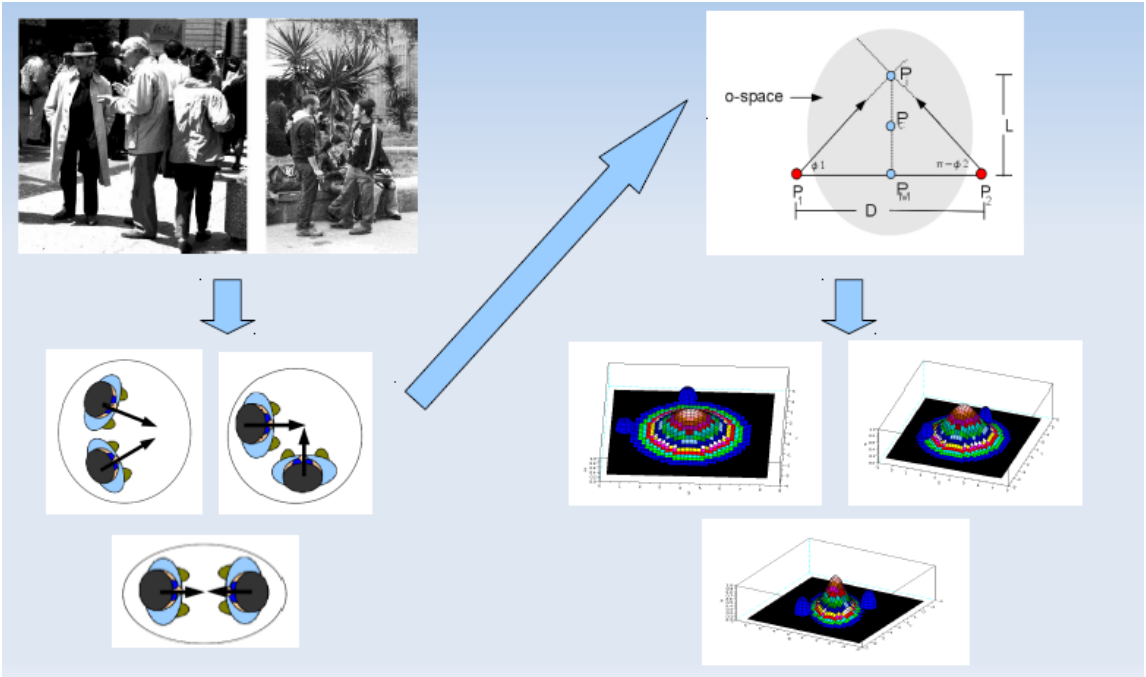
Risk-RRT (C. Fulgenzi)

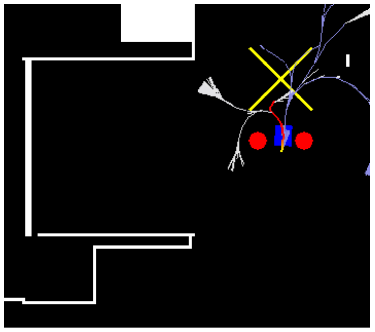


Human aware Navigation (J. Rios Martinez)

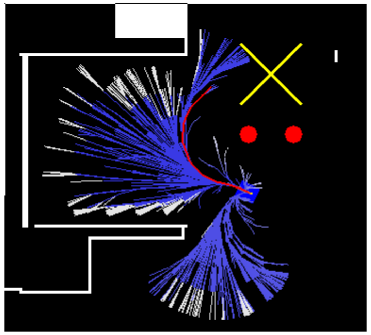
- Personal Space
- Space of interaction
- Navigation among humans based on risk and comfort $P_{conf}(q) = P_{coll}(q) \circ P_{pers} \circ P_{inter}$







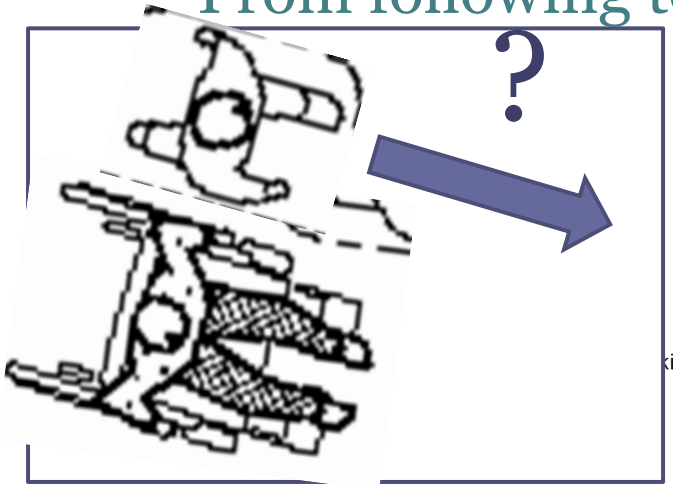
Not taking into account interactions

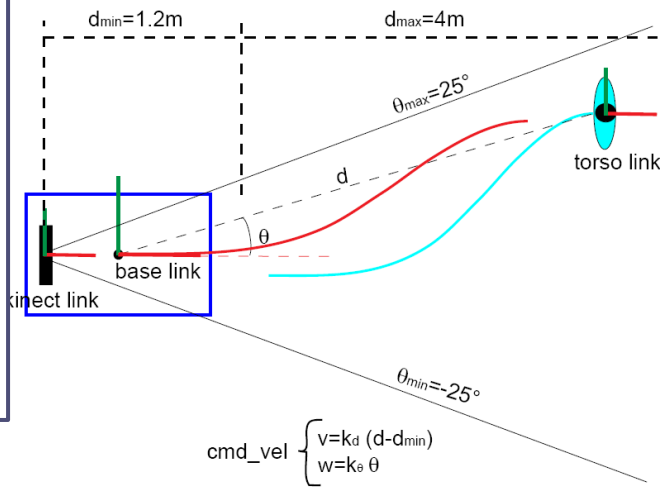


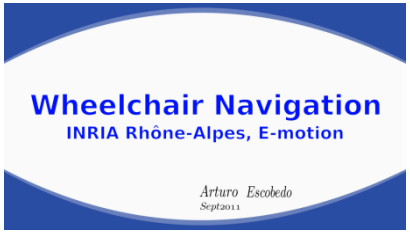
Taking into account interactions

Mobility Assistance (A. Escobedo)

- Navigation system adapted to the person (elder people, disabled, poly disabled…)
  - Autonomy-semi autonomy
  - Interacting with a wheelchair
  - From following to accompanying …







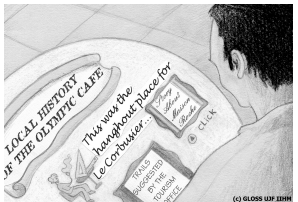
3 Projects of collaboration

- **Common Objectives**
  - **Need analysis and observation** of people's trouble and difficulties
  - **Focus on an adapted technology**
  - **Improve the quality of life**
  - **Improve the mobility and autonomy**
  - **Improve the security**

Elderly and Fragile people: Interacting with a wheelchair

Project of collaboration LIG/INRIA (Spalanzani-Calvary)

- **Plasticity of the interfaces** : adapt the interface to the context of use (user, platform, environment)
  - How to integrate the environment into the user interface
  - How to manage uncertainty and to make it observable to the end-user?
  - How to take benefit from the interaction resources in the surroundings to improve the interaction and/or the quality of life of the end-user?
- **Autonomy/semi autonomy :**
  - Which degree of control should the end-user have in the navigation computation process?
  - How to interact with the system?



Handi-Intelligent wheelchair

Project of collaboration INRIA/Acces-cible-production (Spalanzani-De Borniol)

- Focus on people with **sensory disabilities** and **multiple disabilities** (**mobility impairment** and **sensory disabilities**)
- **Diagnosis** : user needs for the design of numerical devices
- **Adapt** the behavior of the wheelchair to the **level of disability**
- **Adapt** the behavior of the wheelchair to the **context of use** and the environment

Gerontechnologies for people with cognitive impairments

Project of collaboration INRIA/LIRIS/TIMC (Spalanzani-Serna-Rialle)

- Focus on **elder people with cognitive impairments**
- **Build models of users**
- Selection of the **appropriate modalities** of interaction
- Selection of the **appropriate navigation strategies**
- **Conception** of the interactive system and the wheelchair navigation
- **Evaluation** of the system and **improvement** of the prototypes

Other projects

- **ict-PAMM 2011-2013** (personnal assistance for mobility and manipulation)
  - Partners: Kumamoto university, Suwon university, Taiwan university, MICA center and Lasmea.
  - Main topics: wheelchair, manipulation arms, human/ robot communication
- **I-Rice – « International research center of excellence** » on **Human Centered Robotics**.
  - Partners : CNRS, Pierre et Marie Curie University (UPMC), INRIA and the National Taiwan University. Submitted in august 2011.