



HAL
open science

A haptic guidance generic approach

Alexis Boulay, David Daney, Margot Vulliez, Romain Schmitt, Arthur
Bonastre

► **To cite this version:**

Alexis Boulay, David Daney, Margot Vulliez, Romain Schmitt, Arthur Bonastre. A haptic guidance generic approach. JJCR 2023 - Journée des Jeunes Chercheurs en Robotique, Oct 2023, Moliets-et-Maâ, France. hal-04334395

HAL Id: hal-04334395

<https://inria.hal.science/hal-04334395>

Submitted on 11 Dec 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

A haptic guidance generic approach

Alexis Boulay, 2nd year CIFRE PhD student with Farm3

Inria supervisors : David Daney , Margot Vulliez
Auctus Inria, F-33405 Talence, France

Farm3 supervisors : Romain Schmitt, Arthur Bonastre
Farm3, F-25300 Verrières-de-Joux, France

contact : alexis.boulay@inria.fr

Context

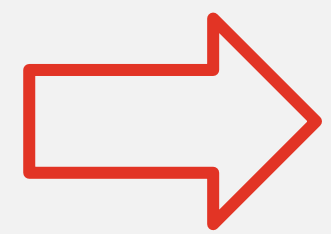
Teleoperation : Allow a human to take control of the robot for remote operation. →

How to ensure interaction performances?

↳ **Shared autonomy :** Enable some robot autonomy for specific simple tasks. →

How to assist a human with more difficult tasks ?

↳ **Haptic guidance :** Generate a force that guides the user to follow a behaviour.

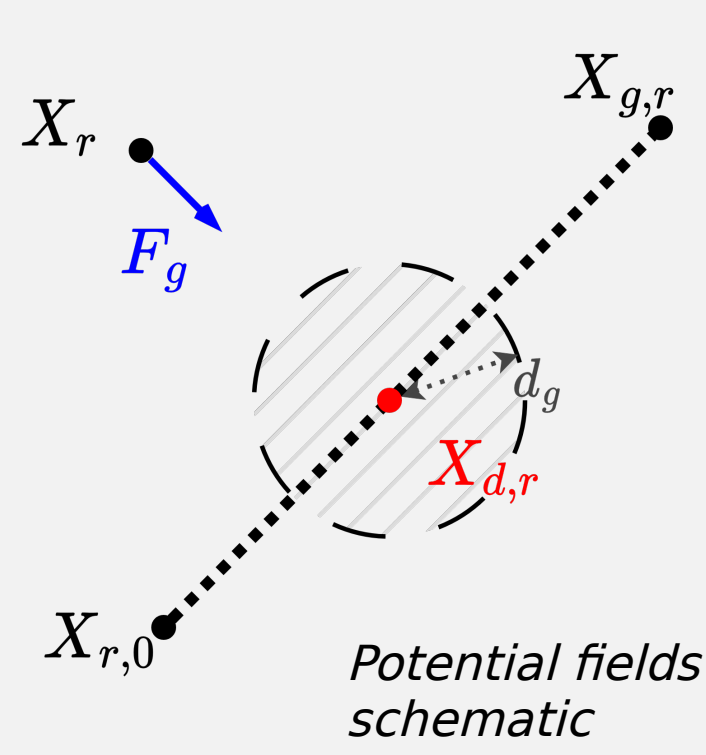


What are the different computation methods for haptic guidance and how can a generic approach be defined ?

Potential fields

Attract or repel operator to a position

- Allow multiple targets
- Free space exploration
- Local minimum

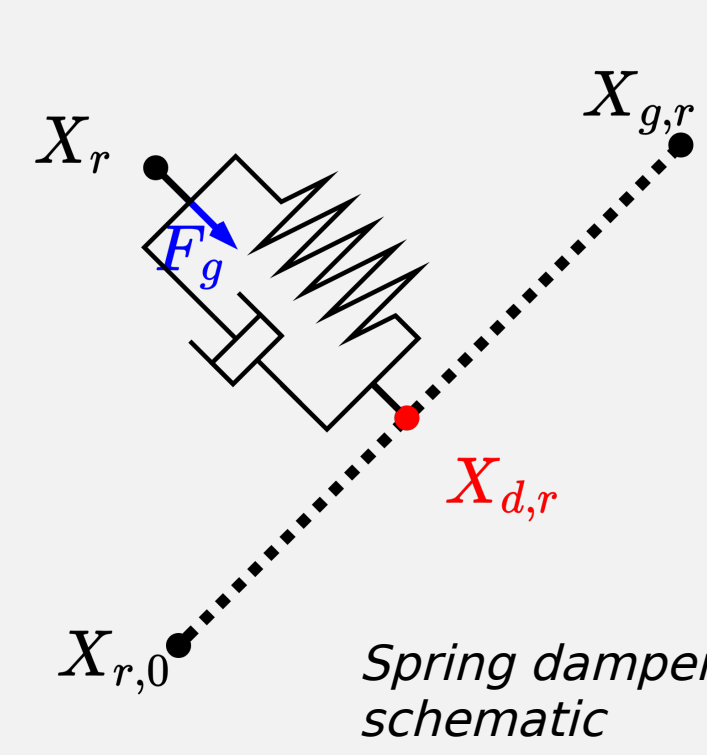


$$f_{PF}(d_{d,r}) = \begin{cases} \frac{d_{d,r}}{d_g^2} & \text{if } d_{d,r} \leq d_g \\ \frac{1}{d_{d,r}} & \text{else} \end{cases}$$

Spring damper

Attach operator to a path

- Unique target
- Allow obstacle avoidance
- Stable

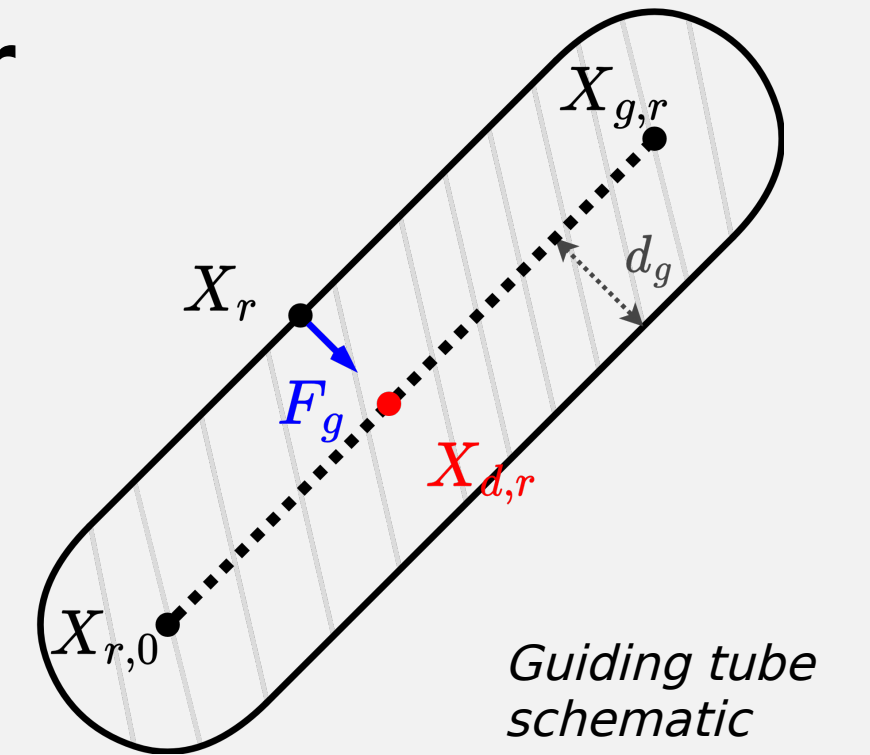


$$f_{SD}(d_{d,r}) = d_{d,r}$$

Guiding tube

Prevent operator from leaving an area

- Multiple geometry
- Limited free space
- Stable



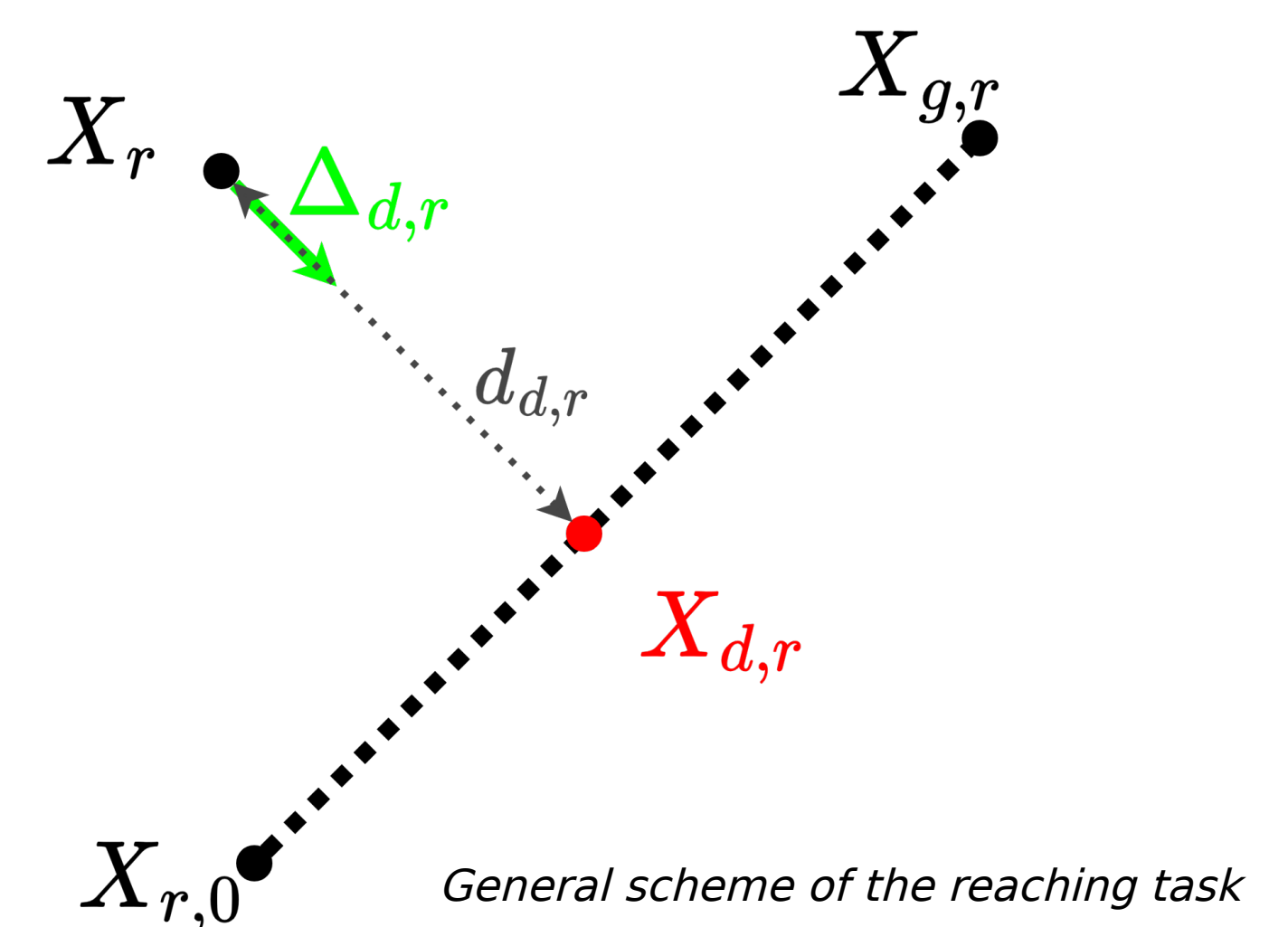
$$f_{GT}(d_{d,r}) = \begin{cases} 0 & \text{if } d_{d,r} \leq d_g \\ (d_{d,r} - d_g) & \text{else} \end{cases}$$

Virtual fixture

Geometric constraint used to generate a haptic guidance

- $f(d_{d,r})$ is the **attraction function** associated with the generic guidance equation, it depends of the distance $d_{d,r}$ between X_r the robot position and $X_{d,r}$ the desired position
- K_g and B_g are generic **impedance** and **damping gains** that can be designed to constrain some directions
- \dot{X}_h is the **haptic device velocity**, it is used for damping to obtain a better reactivity

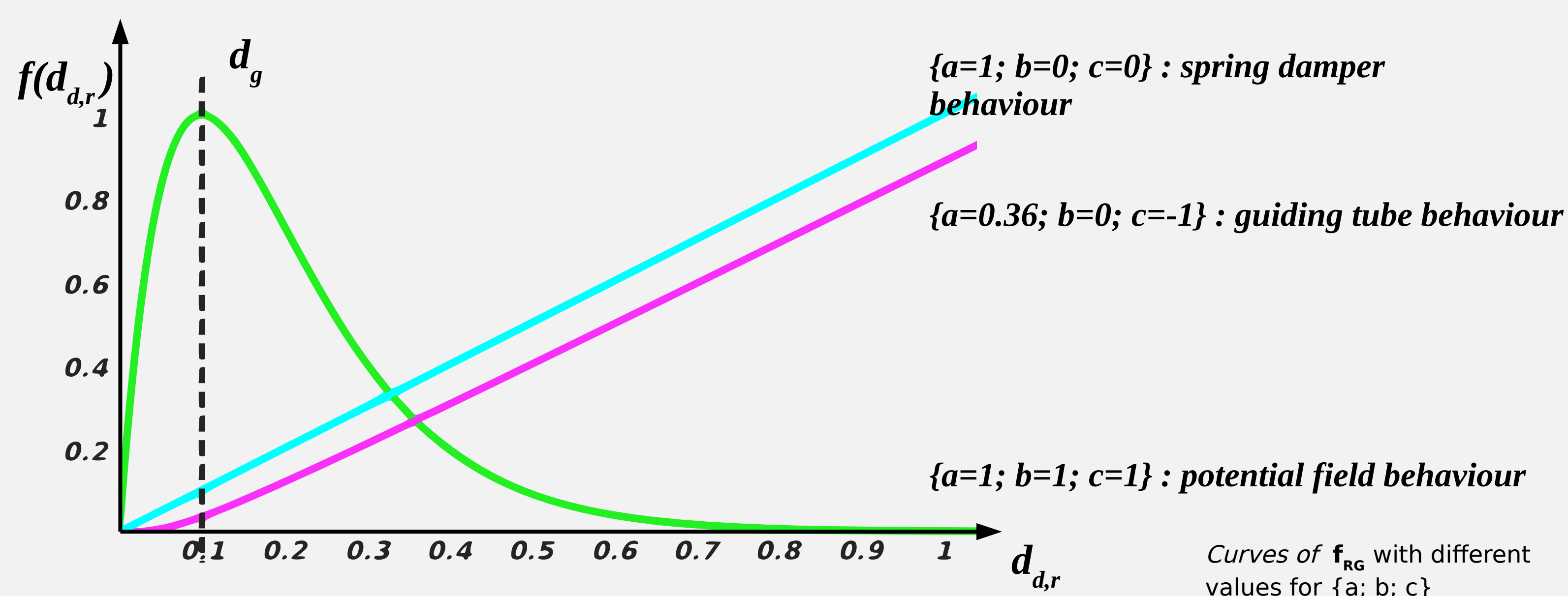
$$F_g = K_g f(d_{d,r}) \Delta_{d,r} - B_g \dot{X}_h$$



Ruling guidance

Use of a generic, parameterised and continuous attraction function

$$f_{RG}(d_{d,r}) = a \frac{d_{d,r}}{(d_g)^b} \exp\left(1 - \left(\frac{d_{d,r}}{d_g}\right)^c\right)$$



- **Continuous** change between the different types of guidance
- Exploration of **intermediate guidance**
- Provide **optimal guidance** relative to the task, the operator and the environment

Experiment

A future experiment will implement and compare different parameterisation of the ruling guidance, and try to define the optimal guidance considering, task, environment and user.

It consists of reaching a plant position in a vertical farm in different scenarios.

