Dimensioning a torpedo-like AUV using interval analysis

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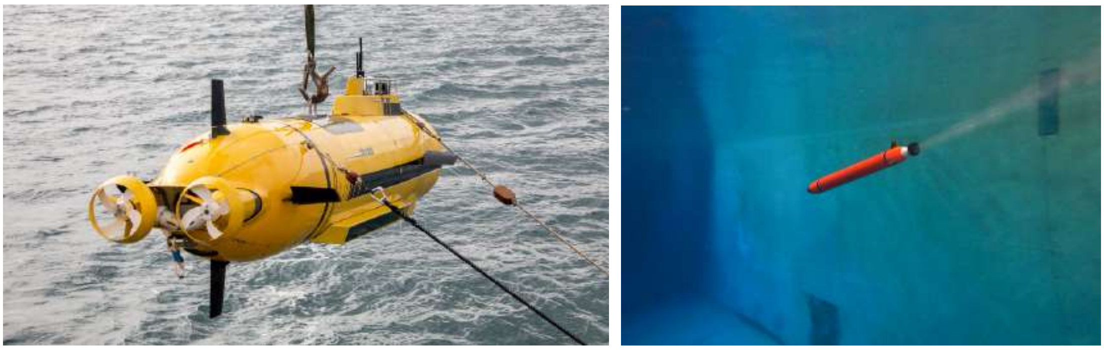
Introduction

Solving a scaling problem saves time when designing a robotic platform. By analyzing the characteristics of already existing systems, we can deduce a set of parameters that must be respected between the physical quantities of our new system.



(a) Daurade [5] (b) Riptide

Figure 1: Example of torpedo-like AUVs

Torpedo-like AUV dimensioning

We consider the problem of dimensioning a torpedo-like AUV (Autonomous Underwater Vehicle). The goal is to design a new robot capable of operating in the trial pool we have at ENSTA Bretagne.

First, a set of equations involving the characteristic quantities of such a robot [1, 2, 5] and a set of parameters need to be expressed to solve this problem.

Then using examples of torpedo-like AUV characteristics, and contractors [3, 4], the set of parameters compatible with these example can be estimated.

Finally, from this estimated set of parameters, and imposed physical quantities on the new robot, the remaining unknown physical quantities to design our new AUV could be deduced using a set inversion algorithm [3, 4].

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Ultra-Wideband based Smart Wheelchair Localization using Interval Analysis

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Introduction

Autonomous navigation for Smart Wheelchairs (SW) [1] enables to enhance the user's autonomy, with, e.g. autonomous docking to a charging station after going to bed. This requires reliable indoor localization. We aim at providing a confidence domain of the pose of a SW, i.e. a box which is guaranteed to contain the true wheelchair position and orientation. The proposed indoor positioning system relies on Ultra-WideBand (UWB) radio modules, with ranging capabilities.

Ultra-WideBand Sensors

A typical UWB-based indoor localization setup is a set of fixed UWB nodes in the room, or *anchors*, from which mobile UWB nodes installed on the robot, or *tags*, measure ranges. We installed such a setup with four anchors in the room and four tags on a SW (see Fig. 1).

Range measurement between an anchor and a tag is performed using two-way ranging, by measuring the time of flight of the UWB signal. The actual range between the two UWB nodes can be determined, assuming line-of-sight (LOS) propagation. In practice, UWB signals are also reflected or blocked by the environment (walls, furniture, people, wheelchair). This may lead to measuring non-line-of-sight

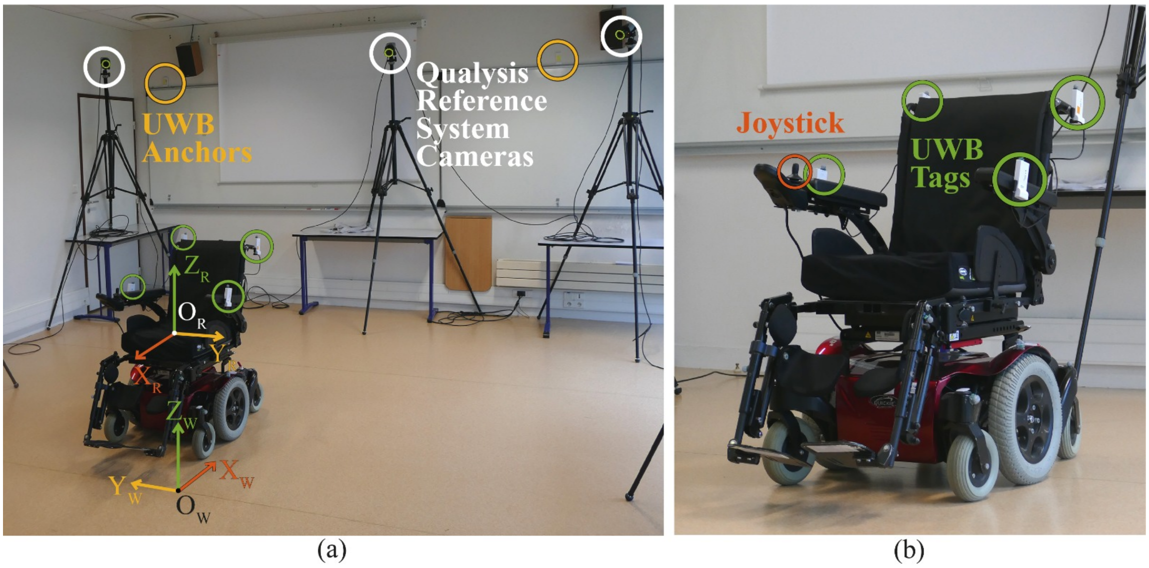

Figure 1: Experimental Setup.

(NLOS) propagation distances, which are longer than the actual distance between the two nodes.

Figure 2 shows the range error distribution of UWB data during trials in which a user was driving the wheelchair while performing daily-life tasks (ground truth comes from a motion capture system). One can distinguish two sources of uncertainties. In LOS conditions, uncertainties are coming from UWB sensors noise, easily handled by a bounded-error model. In NLOS conditions, uncertainties are coming mostly from multipath effects, providing range measurements greater than the actual one, leading to outliers.

Wheelchair Pose Computation

We define the wheelchair pose domain computation as a CSP. Since outliers in range measurements are always positive, we can avoid using q-relaxed intersection [2] and GOMNE methods [3], as long as the wheelchair is inside the polygon defined by the anchors.

- The wheelchair pose (x, y, θ) defines the transformation between the world frame, and the body frame of the wheelchair (in which