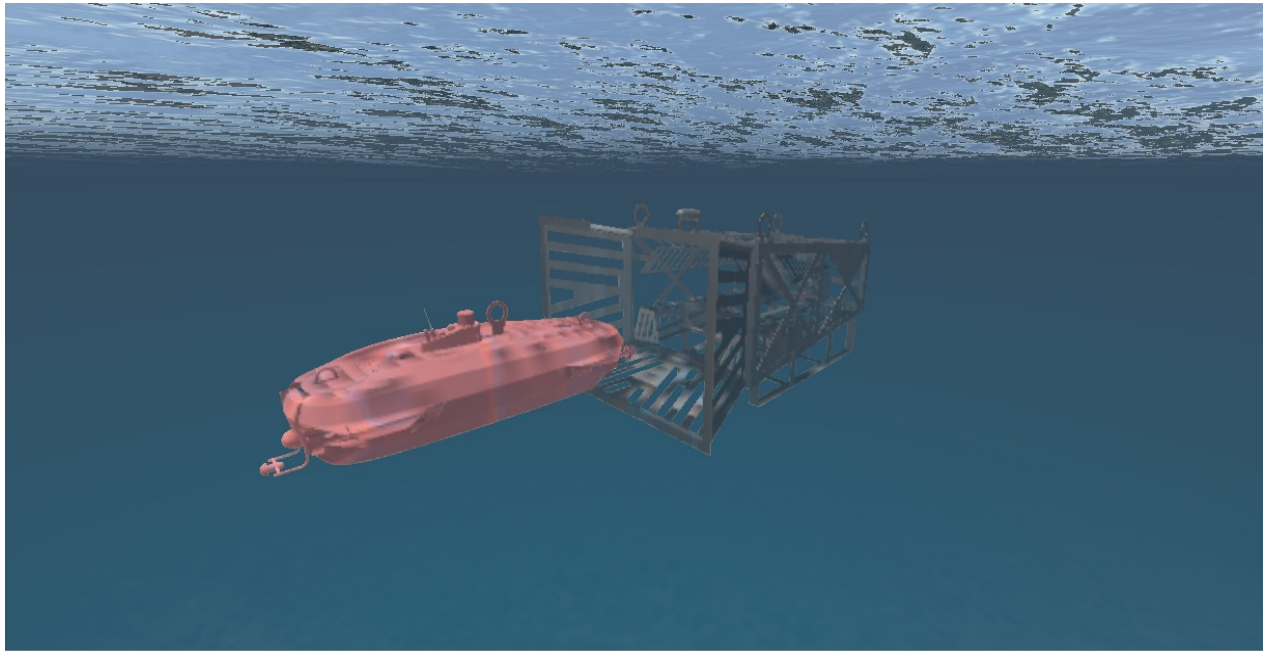
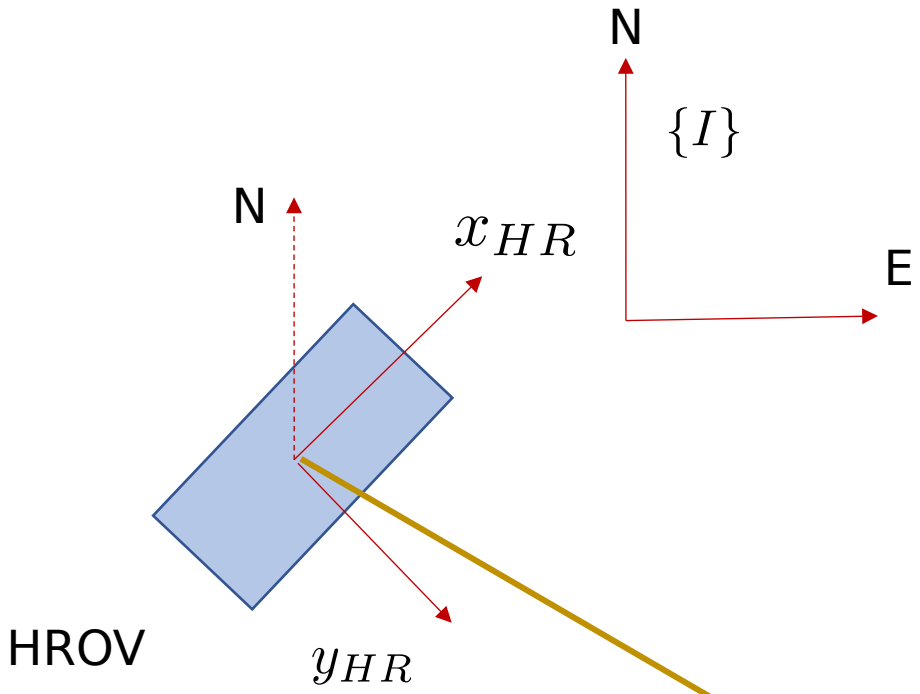
DSOR LAB



Docking of HROV (Hybrid ROV/AUV)

April 3, 2024

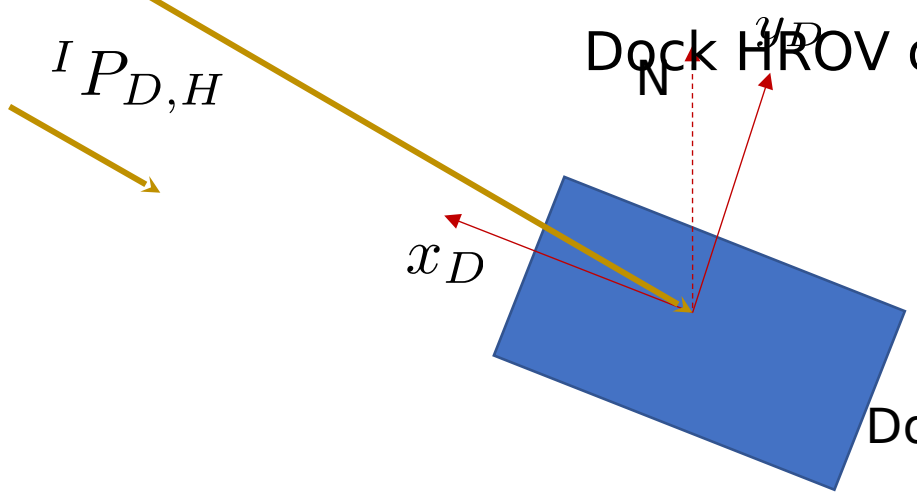


Set up

- HROV equipped with USBL that measures the
  position of the Docking Station (DS) with respect to it
- DS equipped with USBL that measures the
  position of the HROV with respect to it
- HROV equipped with Doppler log and AHRS

Goal

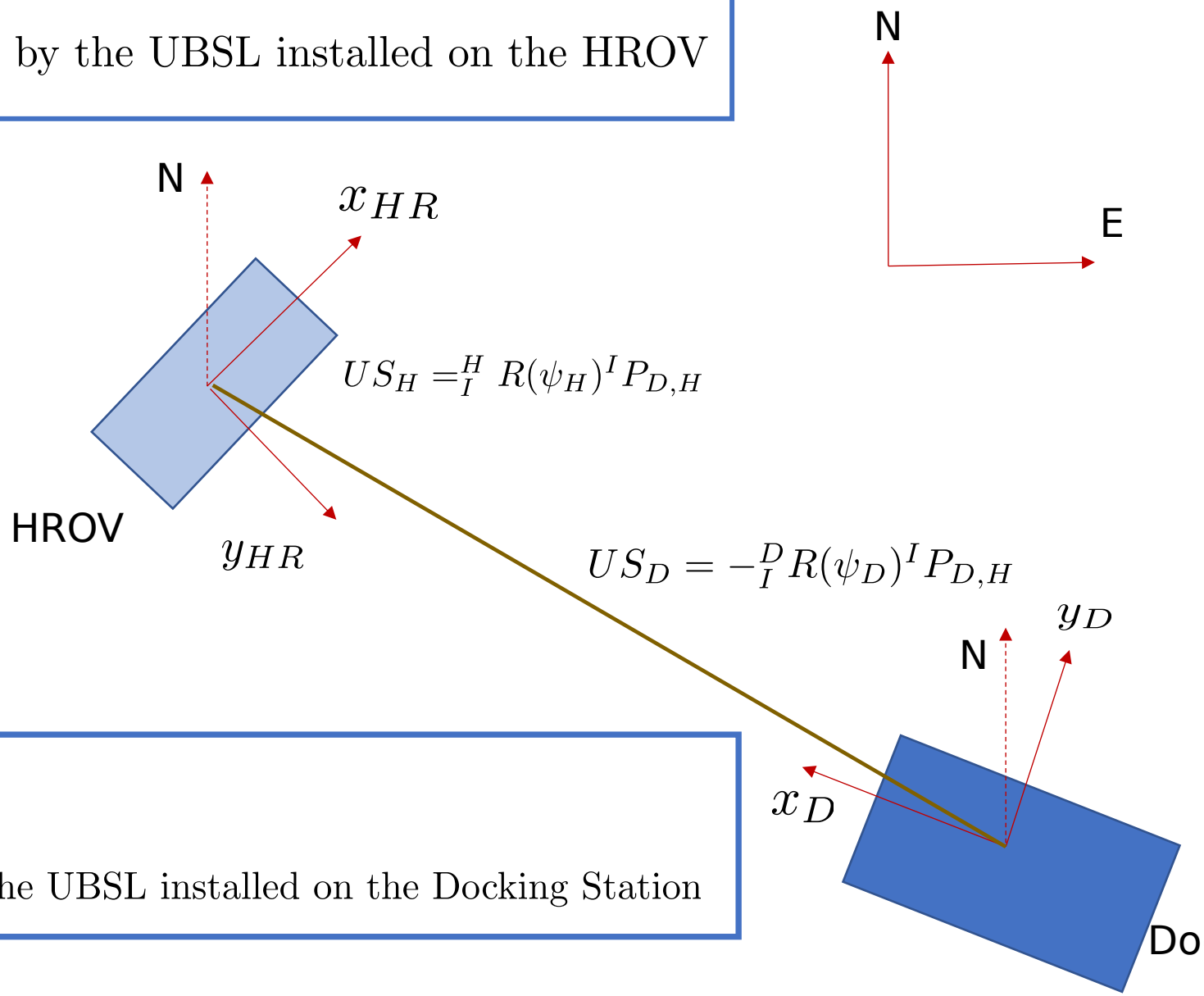
Dock HROV onto DS



Position of DS wrt HROV in Inertial frame $\{I\}$
-directed from DS to HROV

$$USH = {}^{H}_{I}R(\psi_H)\,{}^{I}P_{D,H}$$

USH measurement provided by the UBSL installed on the HROV



$$USD = -{}^{D}_{I}R(\psi_D)\,{}^{I}P_{D,H}$$

USD measurement provided by the UBSL installed on the Docking Station

Problem 1

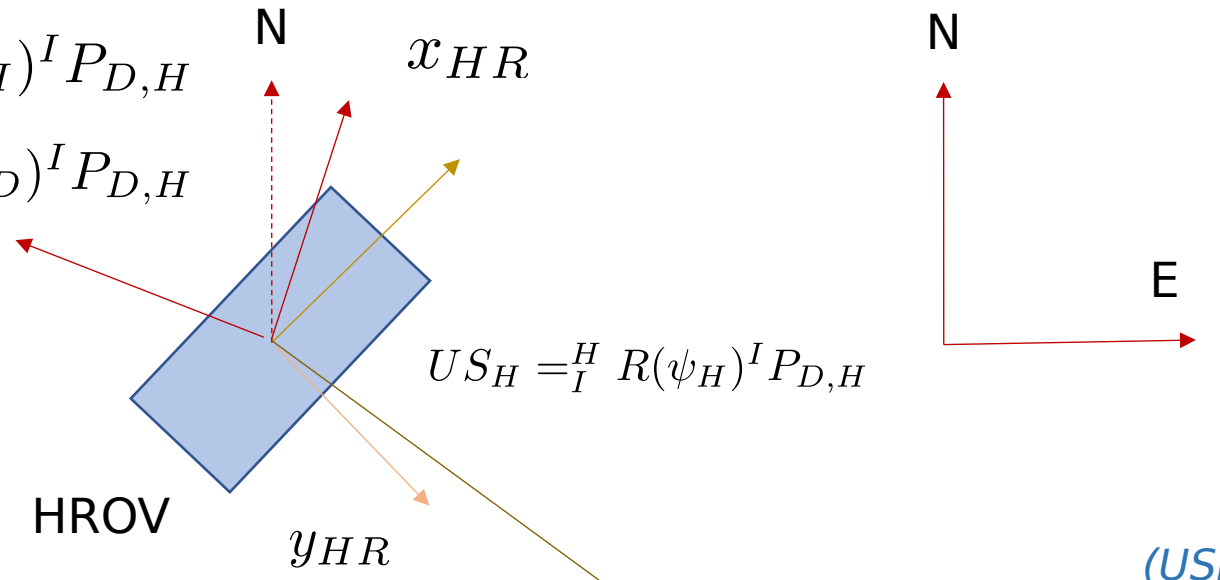
Find the orientation of the Docking Station with respect to the HROV, as captured by the rotation matrix

$$\overset{H}{D}R(.)$$

PROBLEM 1

$$US_H = {}^H_I R(\psi_H)\, {}^I P_{D,H}$$

$$US_D = -{}^D_I R(\psi_D)\, {}^I P_{D,H}$$



Measurements:

$$US_D, US_H$$

(USBL on DStation, USBL on HROV)

$$US_D = -{}^D_I R(\psi_D)\, {}^I P_{D,H}$$

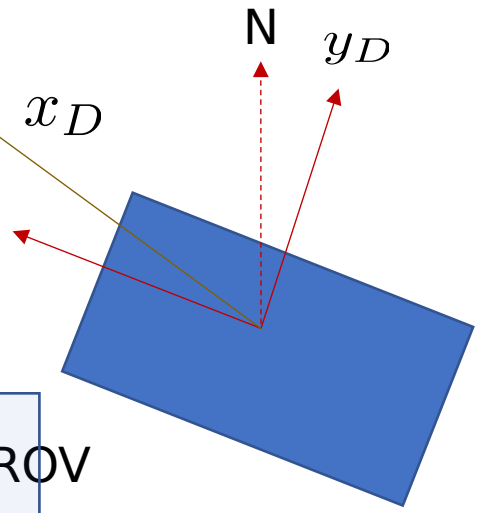
$$^I P_{D,H} = -{}^I_D R(\psi_D) US_D$$

$$^I P_{D,H} = {}^I_H R(\psi_H) US_H$$

$${}^I_H R(\psi_H) US_H = -{}^I_D R(\psi_D) US_D$$

$$US_H = -{}^H_I R(\psi_H)\, {}^I_D R(\psi_D) US_D = -R^H_D(\psi_H, \psi_D) US_D$$

$$US_H = -{}^H_D R(.) US_D$$



Docking Station

${}^H_D R(.)$ Rotation matrix from DS to HROV

$$US_H = -{}^H_D R(.) US_D \qquad {}^H_D R(.) = \frac{1}{r^2}[r_1 r_2; -r_2 r_1]$$

$$Clearly,\ ||US_H|| = ||US_D|| = r\ (range\ measured\ by\ USBLs)$$

Now compute explicitly the rotation matrix ${}^H_D R(.)$ that takes $-US_D$ to US_H

Let

$$r_1 = -\ < US_D, US_H >\qquad r_2 = [0\ 0\ 1][US_D \times US_H]$$

Then

$${}^H_D R(.) = \frac{1}{r^2}\begin{bmatrix} r_1 & -r_2 \\ r_2 & r_1 \end{bmatrix} \rightarrow \theta_{D\rightarrow H} = atan(r_2, r_1)$$