ELECTIVE IN ROBOTICS 2010/11
Short project in Module "Locomotion and Haptic Interfaces"

CyberCarpet Alternative Controller

This project aims at the evaluation of an alternative feedback law for re-centering the walking user on the CyberCarpet platform. The main idea is that only the position (and not the orientation) of the walker is of concern. Therefore simpler control laws could be used from the literature on nonholonomic systems.

In particular, in [1] we considered the problem of navigating with a unicycle mobile robot among obstacles (detected on-line) using potential fields. The goal was to reach a desired position (no orientation specified) and the control law was quite simple (see eq. (16)). This law can be used as the *feedback* component in the controller of the CyberCarpet. In this case, the desired velocities along x and y would come only from the gradient of an attractive potential to the platform center (no obstacles), see eqs. (7) and (13) (the latter will have no repulsive potential). Once the correspondence between the CyberCarpet and a WMR is made, the difference is that the walker is in motion. Thus, a *feedforward* component should still be added to the control law, based on the disturbance observer that we have seen in class, in order to compensate for the estimated intentional velocity of the walker (see the paper [2] summarizing the results presented in class).

The students should apply the feedback control design of [1] and a suitable observer-based feedforward term, designed along the lines of [2], and test the performance in Matlab/Simulink simulations for a series of walker motions. They could consider also a modified version of the theoretical Lyapunov proof of convergence and try to extend the new control approach to the second-order level, i.e., with acceleration inputs.

The supporting material includes:

[1] A. De Luca, G. Oriolo, "Local incremental planning for nonholonomic mobile robots," *1994 IEEE Int. Conf. on Robotics and Automation*, pp. 104-110, 1994.

[2] A. De Luca, R. Mattone, P. Robuffo Giordano, H. Ulbrich, M. Schwaiger, M. Van den Bergh, E. Koller-Meier, and L. Van Gool, "Motion Control of the CyberCarpet Platform," submitted in revised form to *IEEE Trans. on Control Systems Technology*, November 2011.

ADL, November 21, 2011