Computational Intelligence Methods for Dynamic Control of Mobile Robots

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Abstract:

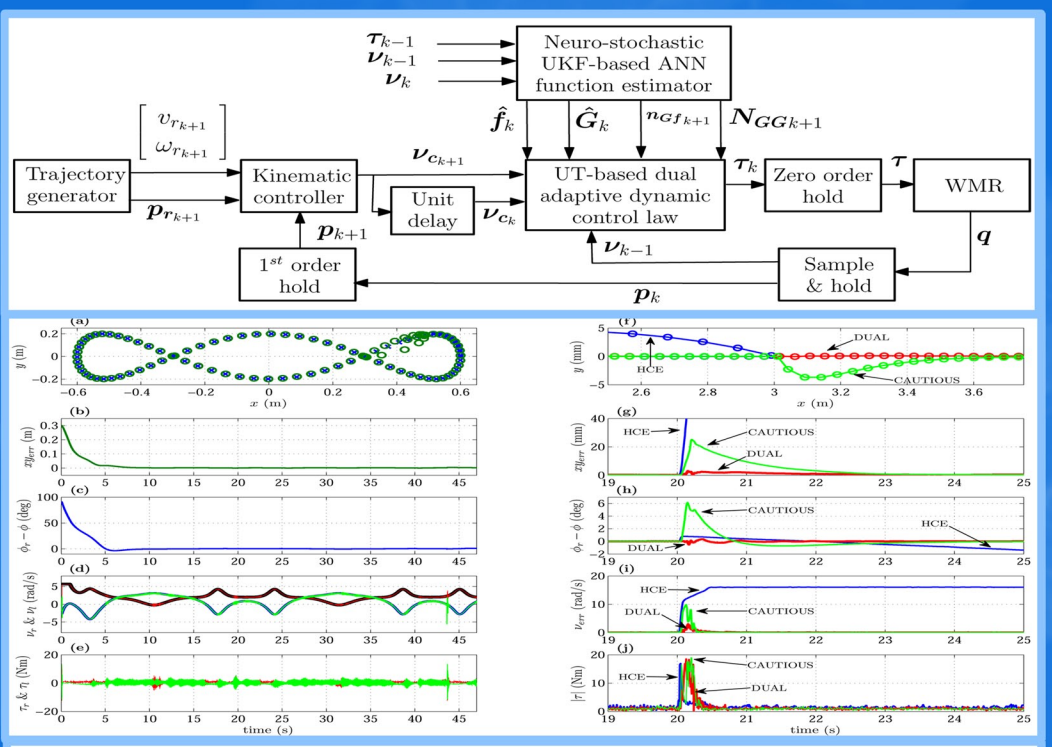
This doctoral work proposes several novel Dual Adaptive Neural Control schemes for the dynamic control of nonholonomic mobile robots. The schemes are developed in discrete time, and the systems's nonlinear dynamic functions are assumed to be unknown. Both Gaussian Radial Basis Function (RBF) and Sigmoidal Multilayer Perceptron (MLP) Neural Networks (NN) are used for function approximation. In each scheme, the unknown network parameters are estimated stochastically in real time, and no preliminary offline neural network training is used.

In contrast to other adaptive techniques hitherto proposed in the literature on mobile robots, the dual control laws presented in our work do not rely on the heuristic certainty equivalence property but account for the uncertainty in the estimates. This results in a major improvement in tracking performance, despite the plant uncertainty and unmodelled dynamics.

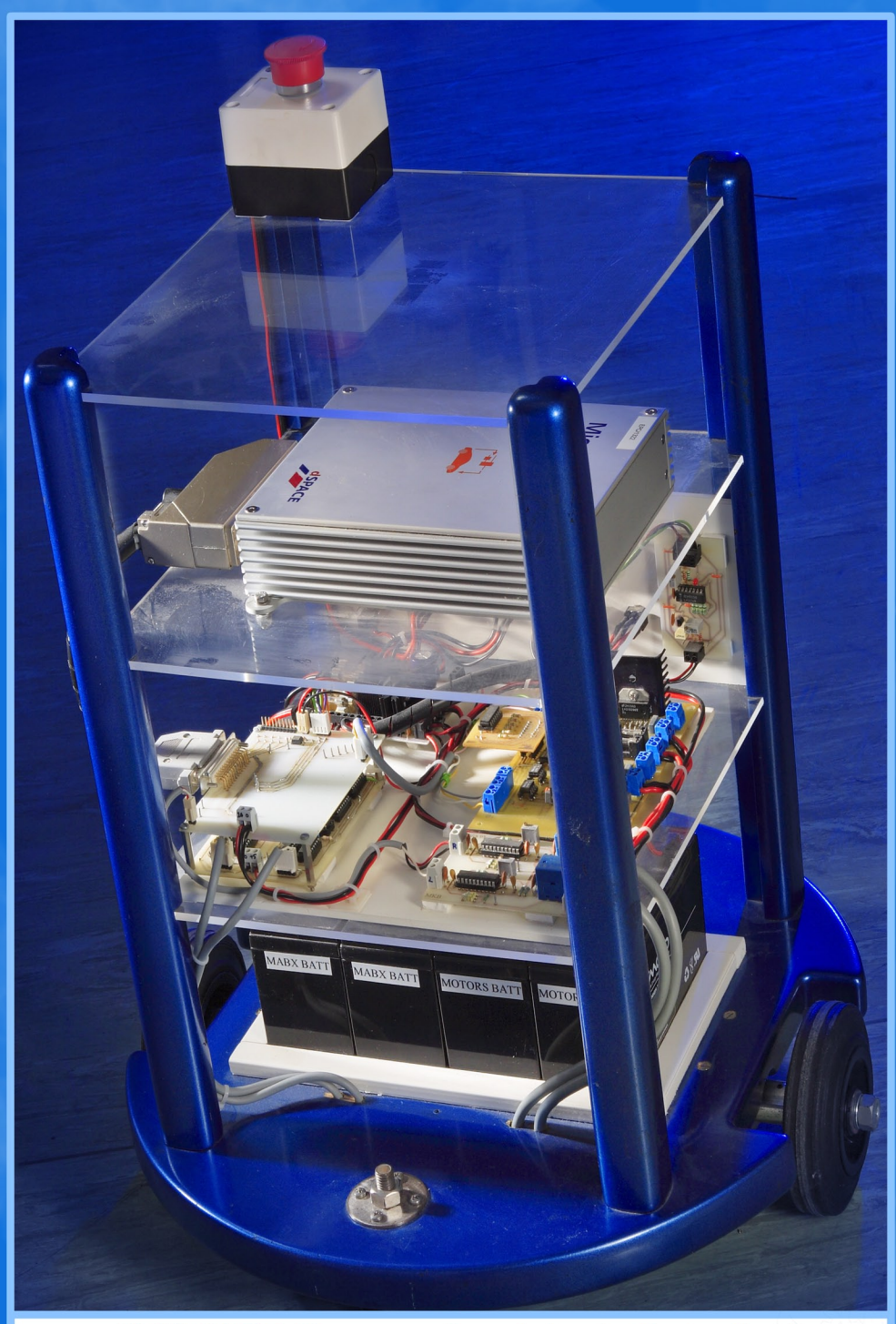
A particularly strong point of our dual-adaptive approaches is that they have been developed for the general case of any Multiple-Input-Multiple-Output (MIMO) affine nonlinear system. Consequently, mobile robotics is only one possible application. These novel algorithms can be readily employed to effect intelligent control of several other systems such as: automobiles, aircraft, robotic wheelchairs and many others.

Novel Contributions:

- Extension of the dual-adaptive neuro controllers proposed for SISO nonlinear systems by Fabri and Kadirkamanathan [2001], to the more general case of MIMO systems.
- Application of the resulting dual-adaptive algo rithms for the control of mobile robots (to the best of our knowledge this is the first use of dual-adaptive control in the filed of robotics).
- Design of a novel dual-adaptive control law based on the unscented transform (UT) (to the the best of our knowledge this is the first time that the UT is being used in the context of du al-adaptive control)
- Design and Construction of a state-of-the-art wheeled mobile robot NERUOBOT, to serve as an experimental testbed for our research.



Our recently proposed Dual-Adaptive Control Scheme based on the Unscented Transform - block diagram and experimental results.



NEUROBOT: Our experimental robotic testbed