Cooperation is increasingly being applied in the control of interconnected multi-agent systems, and it introduces many benefits. In particular, cooperation can improve the efficiency of many types of missions, and adds flexibility and robustness against external disturbances or unknown obstacles. This thesis investigates cooperative maneuvers for aerial vehicles autonomously landing on moving platforms, and how to safely and robustly perform such landings on a real system subject to a variety of disturbances and physical and computational constraints. Two specific examples are considered: the landing of a fixed-wing drone on top of a moving ground carriage; and the landing of a quadcopter on a boat. The maneuvers are executed in a cooperative manner where both vehicles are allowed to take actions to reach their common objective while avoiding safety based spatial constraints. Applications of such systems can be found in, for example, autonomous deliveries, emergency landings, and search and rescue missions. Particular challenges of cooperative landing maneuvers include the heterogeneous and nonlinear dynamics, the coupled control, the sensitivity to disturbances, and the safety criticality of performing a high-velocity landing maneuver.

The thesis suggests the design of a cooperative control algorithm for performing autonomous and cooperative landings. The algorithm is based on model predictive control, an optimization-based method where at every sampling instant a finite-horizon optimal control problem is solved. The advantages of applying this control method in this setting arise from its ability to include explicit dynamic equations, constraints, and disturbances directly in the computation of the control inputs. It is shown how the resulting optimization problem of the autonomous landing controller can be decoupled into a horizontal and a vertical sub-problem, a finding which significantly increases the efficiency of the algorithm. The algorithm is derived for two different autonomous landing systems, which are subsequently implemented in realistic simulations and on a drone for real-world flight tests. The results demonstrate both that the controller is practically implementable on real systems with computational limitations, and that the suggested controller can successfully be used to perform the cooperative landing under the influence of external disturbances and under the constraint of various safety requirements.