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Design and Control of the Lift Subsystem of a Two-Wheeled Forklift Robot

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Abstract. This thesis proposes the mechanical design and control of the lift subsystem of a Two-Wheeled Forklift Robot (TWFR). Vertical movement is achieved by employing a ball screw linear actuator that creates a movement of the fork relative to the main body of the robot. Vertical stabilization and trajectory generation of the robot are achieved by implementing a precise positioning of the Center of Gravity (CoG) of the complete system; this positioning considers the dynamic effects of changing the height of the load by the implementation of Reaction Torque Observers (RTOBs) and a special Inverse Kinematics (IK) solution that takes into account not only the position of the end effector but also the coordinates of the CoG. The low-level strategies for controlling pitch angle, fork angle, and lift height implement different disturbance observers and PD controllers to move the end effector and CoG to the desired position relative to the main axis of the wheels, allowing also a precise generation of the system trajectory. The performance of the trajectory generation and control strategies is tested in simulation to validate the proposed architecture.

Keywords: Two-Wheeled Robot (TWR), Mechanical design, Disturbance observer, Motion planning, Model-based control.