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Wheeled Robot Stable Braking Process under Asymmetric Traction Coefficients

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Abstract : During the wheeled robot's braking process, the extra dynamic vertical forces act on all wheels: left, right, front or rear. Those forces are directed downward on the front wheels while directed upward on the rear wheels. In order to maximize the deceleration, therefore, minimize the braking time and braking distance, we need to calculate a correct torque distribution: the front braking torque should be increased, and rear torque should be decreased. At the same time, we need to provide better transversal stability. In a simple case of all adhesion coefficients being the same under all wheels, the torque distribution may secure the optimal (maximal) control of the robot braking process, securing the minimum braking distance and a minimum braking time. At the same time, the transversal stability is relatively good. At any time, we control the transversal acceleration. In the case of the transversal movement, we stop the braking process and re-apply braking torque after a defined period of time. If we correctly calculate the value of the torques, we may secure the traction coefficient under the front and rear wheels close to its maximum. Also, in order to provide an optimum braking control, we need to calculate the timing of the braking torque application and the timing of its release. The braking torques should be released shortly after the wheels passed a maximum traction coefficient (while a wheels' slip increases) and applied again after the wheels pass a maximum of traction coefficient (while the slip decreases). The correct braking torque distribution secures the front and rear wheels, passing this maximum at the same time. It guarantees an optimum deceleration control, therefore, minimum braking time. In order to calculate a correct torque distribution, a control unit should receive the input signals of a rear torque value (which changes independently), the robot's deceleration, and values of the vertical front and rear forces. In order to calculate the timing of torque application and torque release, more signals are needed: speed of the robot: angular speed, and angular deceleration of the wheels. In case of different adhesion coefficients under the left and right wheels, but the same under each pair of wheels- the same under right wheels and the same under left wheels, the Select-Low (SL) and select high (SH) methods are applied. The SL method is suggested if transversal stability is more important than braking efficiency. Often in the case of the robot, more important is braking efficiency; therefore, the SH method is applied with some control of the transversal stability. In the case that all adhesion coefficients are different under all wheels, the front-rear torque distribution is maintained as in all previous cases. However, the timing of the braking torque application and release is controlled by the rear wheels' lowest adhesion coefficient. The Lagrange equations have been used to describe robot dynamics. Matlab has been used in order to simulate the process of wheeled robot braking, and in conclusion, the braking methods have been selected.

Keywords : wheeled robots, braking, traction coefficient, asymmetric
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