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# 基于滚动阻力实时监测的软路面识别方法

# Identification of soft roads by real-time monitoring of rolling resistance

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中文摘要:

为提高某军用越野车辆在软路面的机动性，提出一种基于滚动阻力实时监测的软路面识别方法。利用软路面测量的特征参数计算出土壤"圆锥指数"（cone index,CI）；依据贝克的地面力学"压力-沉陷"公式获得主要由土壤压实阻力构成的车轮滚动阻力系数；通过实时监测车辆和发动机动的运行状态，基于车辆纵向力平衡方程，根据发动机的输出扭矩计算车辆当前行使路面的滚动阻力系数，并与软路面滚动阻力系数临界阈值进行对比。若为软路面则采取车辆软路面的行使模式，使得车辆快速通过。该文实现了车辆对软路面的自我识别，识别率达90%，提高了越野车辆的机动性能。

英文摘要:

Abstract: The development of the automotive technology makes the vehicle mobility possible. The current technologies commonly used include active suspension, intelligent differential lock, central tire inflation system, and torque control-based engine technology. These new technologies cannot be applied unless the road character is predicted by the vehicle. Soil support strength "cone index" (CI, pound/inch2) can be classified into 3 categories: 30-75, 75-125, and > 125. Based on the CI classification, the road also can be classified. On the road with CI Category 1, the vehicle usually cannot go through; on the road with CI Category 2, the vehicle can pass through quickly by the soft road pattern; and the road with CI Category 3 can barely affect the mobility of the vehicle. In this study, to identify the soft road, the rolling coefficients threshold based on the experiences was established between Category 1 and Category 2. It assumed that the mobility of the vehicle would be better improved if a vehicle identified the road feature and then adjusted the vehicle-self running at the soft pattern automatically. To increase the mobility of the military off-road vehicle, one identification method of the soft roads based on real-time monitoring of the rolling resistance was put forward. Since the tire barely deformed, it could be regarded as a rigid-body when a vehicle was running on a soft road. The width of the tire could affect the coefficient of the rolling resistance, but the character parameters of soft roads were the major factors affecting coefficient of the rolling resistance. When the vehicle was driven on soft road, the movement of the vehicle could be prevented by soft soil because not all soil counterforce were effective, for example, some of the resistance forces did not produce propulsive force but were consumed to make soil deformation. The character parameters of soft roads in Institute of Changchun Wetland were measured and the CI was calculated. The rolling resistance of a wheel on real compact terrain was calculated based on Bakker's terramechanics pressure-sinkage equation. The results showed that the rolling resistance was less than 0.03 when the vehicle ran on concrete road, less than 0.1 on hard road, and greater than 0.2 on sand. Therefore, the rolling resistance of 0.2 was considered as the critical value for soft road identification. In a real condition when a vehicle ran on a road, by real-time monitoring the running condition of a vehicle and its engineer on real roads, the coefficient of the rolling resistance could be calculated based on the longitudinal force equation using the engine transient output torsion. If the obtained coefficient of the rolling resistance was greater than 0.2, the vehicle would run at a soft road pattern and pass through the soft road more quickly. In a test study, the accuracy of a vehicle successfully identifying road condition reached 90%, confirming that the rolling resistance-based soft road identification method proposed here was reliable.

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