Torque Ripple in Robotics Applications

Permanent magnet synchronous motors or PMSMs are commonly used in multiple applications, both in industry and commercial use. These motors are often implemented in industrial robot servo systems which include a driver and motor, referred to as servo motors and servo drives. PMSMs have many pros (such as high torque density and efficiency) when compared to other electrical machines but do present the issue of torque ripple, especially cogging torque. One field that is particularly affected by this is industrial robotics applications, both because of the high demands on the robot because of the tasks they perform as well as how the different parts of the robot interact with each other. This makes the suppression of torque ripple crucial. This paper attempts to documented and compensate the ripple of one such PMSM. The motor in question has had an issue in its use in robots because of its ripple. By looking into machine design, motor drivers and control theory it is concluded that source of the ripple is not the commonly assumed cogging torque but rather magnetic saturation and core losses, expressing themselves through excitation of the sixth harmonic. This harmonic excitation can be simply explained as a regularity in the ripple that can be observed an constant number of times per motor revolution. The recommended solution to the issue is a method called current injection which works by minimizing the effects of the harmonic. Using this method the motor does not need to be redesign, meaning that existing motors can continue to be used.