TO STUDY STRATEGY OF STARTING SENSORLESS BLDCM WITH INDUCTANCE METHOD AND EMF INTEGRATION

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ABSTRACT

In, conventional 3-stage start-up method of sensorless brushless direct current motor (BLDCM), the rotor is likely to jitter because rotor position cannot be obtained, and the motor is apt to lose step when it starts with load. These defects limit its use in engineering applications. In order to achieve smooth start in specific direction and guarantee start-up success rate with load, a start-up method based on improved inductance method and electromotive force (EMF) integration is proposed applying different voltage vectors according to rotor position interval judged by inductance method and determining integrator start-up time according to rotor initial position and the EMF. Experiments show that the method guarantees smooth acceleration and increases start-up success rate with load.

Keywords: ***PMBLDC motor; sensors; controllers; sensorless operation; torque pulsations.***

NEW METHOD FOR START-UP

1. Identify the Initial Rotor Position.

Conventional inductance method adopts two-to-two or three-to-three conducting methods, applying six-voltage vector in different direction continually and locating the rotor position in the scope of $\pi/3$. When using the traditional method, there are two problems: one is that the rotor position cannot be determined precisely, the other is that applying six-voltage vectors at the same time will make the arbitration rules complicated and the programming code lengthy. The improved inductance method is adopted in this paper, which can determine the rotor position in the scope of $\pi/6$ easily and has simple arbitration rules. It can be linked up with the EMF integration when it starts. The advantage of EMF integration will be more obvious in this way. Sampling quantity and calculated amount decrease and stability increases, which will make the improved effect of start-up more obvious. The improved inductance method proposed in this paper follows: when the motor is static, utilize two-to-two conducting method to apply voltage pulse to the MOSFET. Assuming that the rotor position is shown in Figure 3, firstly apply two-voltage vectors VAB (direction C) and VBA (direction Z) in the opposite direction for a while. $I2$ and $I5$ are collected and stored as bus current separately.

Because the magnetic saturation of the iron core is different, the sizes of $I2$ and $I5$ are also different. If $I2 > I5$, from the analysis above, it can be known that the N pole of the rotor is on the left side of line I-II. The rotor is located in the scope of π for the first time. Then apply two-voltage vectors VCB (direction X) and VAC (direction Y) for a while and collect bus currents which can be stored as $I3$ and $I1$.

According to the arbitration rules in this paper, the rotor area can be judged in different conditions. The arbitration rules are as follows: if $I2 - I1 > 0$, a=1 or a=0. If $I2 - I3 > 0$,b=1 or b=0. Bring the results into the arbitration formula $y = 2a + b$. If y=1, the rotor is in area 1. If y=3, the rotor is in area 2. If y=2, the rotor is in area 3. The rotor position in the right side of I-II can be judged in the same way. In this way, the rotor position can be determined in the range of $\pi/3$. According to the assumption above, the rotor should be in area 1. According to the result of location, apply VBC again and collect bus current and store it as $I6$. Now, there are three positions that the rotor may be in: Y coordinate or a position shift from the Y coordinate by a distance within the range of $\pi/6$.The method in this paper is treated as the same condition of the rotor in Y coordinate or above the Y coordinate within the range $\pi/6$. Comparing $I6$ with $I2$, the rotor position can be determined in the scope of $\pi/6$. According to the assumption above, the result now should be $I2 < I6$ and the N pole of the rotor should be above the Y coordinate within the range of $\pi/6$. The judgment of the position of other rotor is similar.

2. EMF Integration Start-Up.

According to the above, the rotor position is already determined in the range of $\pi/6$ and the voltage vector can be applied to the rotor according to the torque maximized and predefined rotate direction. Two conditions will come across when the voltage vector is applied: the first is the EMF of nonconducting phase that has already crossed zero, the second is that EMF of nonconducting phase that has not crossed zero. If the rotor position is in the shadow area in now, the power is supplied towards Z direction, and the rotor position has not crossed zero, so the EMF of C phase should be collected. When the voltage vector is VBA, the initial EMF of C phase is minus. The electrical direction should be constant at this moment until the C phase EMF appears zero crossing point. This zero-crossing point is the common commutation zero-crossing point. Because of the undetermined load, in order to avoid the condition where commutation is too rapid and the rotor rotates in reverse with jitter because of the heavy load, the integrator should be started at the moment when the zero-crossing point is detected. The result of the integration is compared with the integration threshold value on time. If it overflows, the motor will be commutated at once and proceed into the acceleration process. If the rotor position is in the shadow area in now and the power is supplied in A direction by utilizing two-to-two conducting method, now the rotor position is between the zero-crossing point and commutation point.

CONCLUSION

The advantages of the inductance method and the EMF integration are amazed in detail in this paper. And, after combining these two methods, a new start-up method for sensorless BLDCM is proposed. The integrator start-up time is determined by implementing the improved inductance method and the new arbitration rules. The experiment demonstrates the advantages of the new start-up method proposed in this paper compared to the traditional one in start-up stage. The location of the rotor when the motor is static is realized, and the commutation signal and the rotor position can be synchronized at once. It increases the startup success rate with load and improves rapidity and stability of the current response.

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