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Discussion on “A Differential Algebraic Estimator for Sensorless Permanent-Magnet Synchronous Machine Drive”

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Diao et al. \cite{S. Diao, D. Diallo, Z. Makni, C. Marchand, and J. Bisson, “A differential algebraic estimator for sensorless permanent-magnet synchronous machine drive,” Energy Conversion, IEEE Transactions on, vol. 30, pp. 82–89, March 2015.} are to be commended for proposing a new approach for permanent magnet synchronous machine (PMSM) position estimation, using the differential algebraic theory. In the following comments, we would like to highlight some points concerning the machine observability under the applied approach.

In the paper by Diao et al. \cite{S. Diao, D. Diallo, Z. Makni, C. Marchand, and J. Bisson, “A differential algebraic estimator for sensorless permanent-magnet synchronous machine drive,” Energy Conversion, IEEE Transactions on, vol. 30, pp. 82–89, March 2015.}, it is claimed that the rotor position observability of the non-salient PMSM is ensured regardless the speed, based on the relationship (8) in \cite{S. Diao, D. Diallo, Z. Makni, C. Marchand, and J. Bisson, “A differential algebraic estimator for sensorless permanent-magnet synchronous machine drive,” Energy Conversion, IEEE Transactions on, vol. 30, pp. 82–89, March 2015.}. Indeed, (8) is another way to write the back-electromotive force (EMF)-based estimator equation for the non-salient PMSM:

\[
\frac{v_{s\alpha} - R_s i_{s\alpha} - L_d \frac{di_{s\alpha}}{dt}}{v_{s\beta} - R_s i_{s\beta} - L_d \frac{di_{s\beta}}{dt}} = -\omega \phi_m \sin \theta \quad (2)
\]

\[
\frac{v_{s\beta} - R_s i_{s\beta} - L_d \frac{di_{s\beta}}{dt}}{v_{s\beta} - R_s i_{s\beta} - L_d \frac{di_{s\beta}}{dt}} = \omega \phi_m \cos \theta \quad (3)
\]


The fact that the rotor position observability is not ensured at standstill is illustrated in the Fig. 4 of the paper \cite{S. Diao, D. Diallo, Z. Makni, C. Marchand, and J. Bisson, “A differential algebraic estimator for sensorless permanent-magnet synchronous machine drive,” Energy Conversion, IEEE Transactions on, vol. 30, pp. 82–89, March 2015.}, where an initial position estimation error is introduced; the position estimate is not corrected at standstill.


In this case, the rotor position can be identified at standstill if the first derivative of $i_q$ is different from zero.

\begin{align}
\tan \theta &= \frac{-e_{\alpha}}{e_{\beta}} \\
\tan \theta &= -\frac{y_1 L_d + R_s y_1 + \omega(L_d - L_q) y_2 - u_1}{y_2 L_d + R_s y_2 - \omega(L_d - L_q) y_1 - u_2} \quad (5)
\end{align}

\begin{equation}
\begin{bmatrix}
e_{\alpha_{\text{ext}}} \\
e_{\beta_{\text{ext}}}
\end{bmatrix} = \begin{bmatrix}
(L_d - L_q)(\omega i_d - \frac{di_q}{dt} + \omega \phi_m) \\
-\sin \theta \\
\cos \theta
\end{bmatrix} \quad (4)
\end{equation}

\begin{thebibliography}{9}
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