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comparative study between the experimental implementation of an open loop observer and EKF observer with DTC of induction motor

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INTRODUCTION & AIM

Direct Torque Control (DTC) is a popular technique for controlling induction motors due to its simplicity and fast dynamic response [1]. However, a major challenge in DTC is the accurate estimation of stator flux and speed, which are typically obtained using open-loop estimators. These estimators can be susceptible to parameter variations and disturbances, leading to performance degradation [2].

To address these limitations, various state estimation techniques have been proposed, including the Extended Kalman Filter (EKF). The EKF is a powerful tool for nonlinear state estimation, capable of handling uncertainties in system dynamics and measurements [3]. By incorporating a priori knowledge about the system and measurement noise, the EKF can provide more accurate estimates of the stator flux and speed, even in the presence of disturbances [4]. This comparative study aims to investigate the performance of DTC with both open-loop and EKF-based estimators. By analyzing the dynamic response, robustness to parameter variations, and sensitivity to noise, we will evaluate the advantages and disadvantages of each approach. The findings of this study will provide valuable insights for the design and implementation of high-performance DTC systems.

METHOD

Figure 1 shows the open-loop LPF estimator used to estimate stator flux.

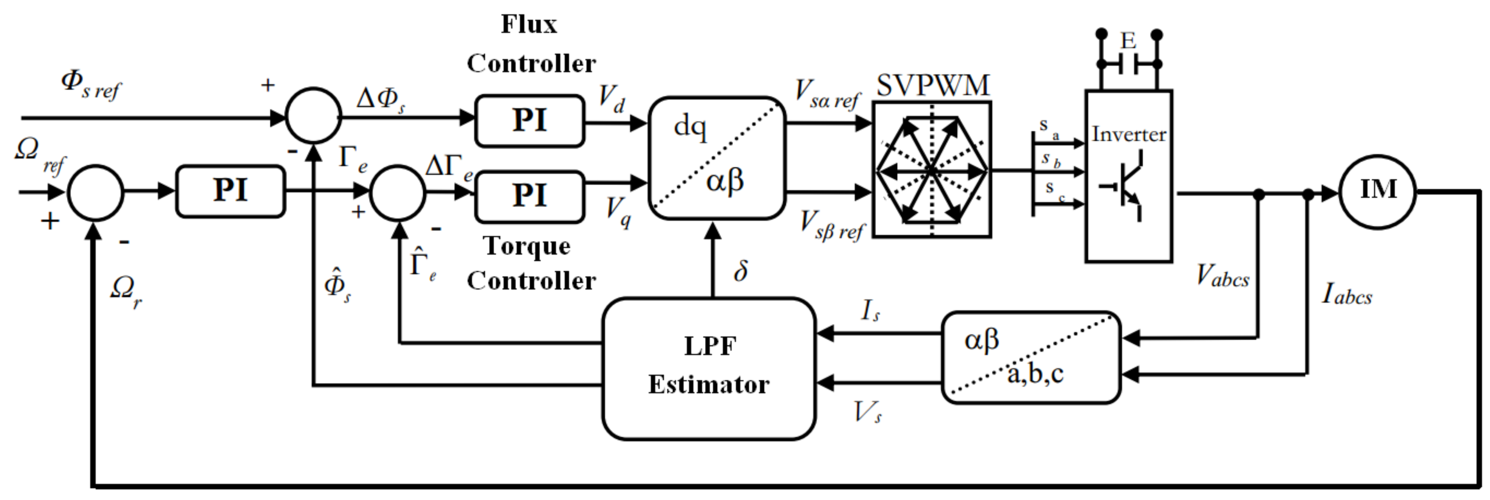

fig1. DTC of induction motor with LPF estimator

Figure 2 illustrates the closed-loop estimator (EKF observer) used to estimate stator flux.

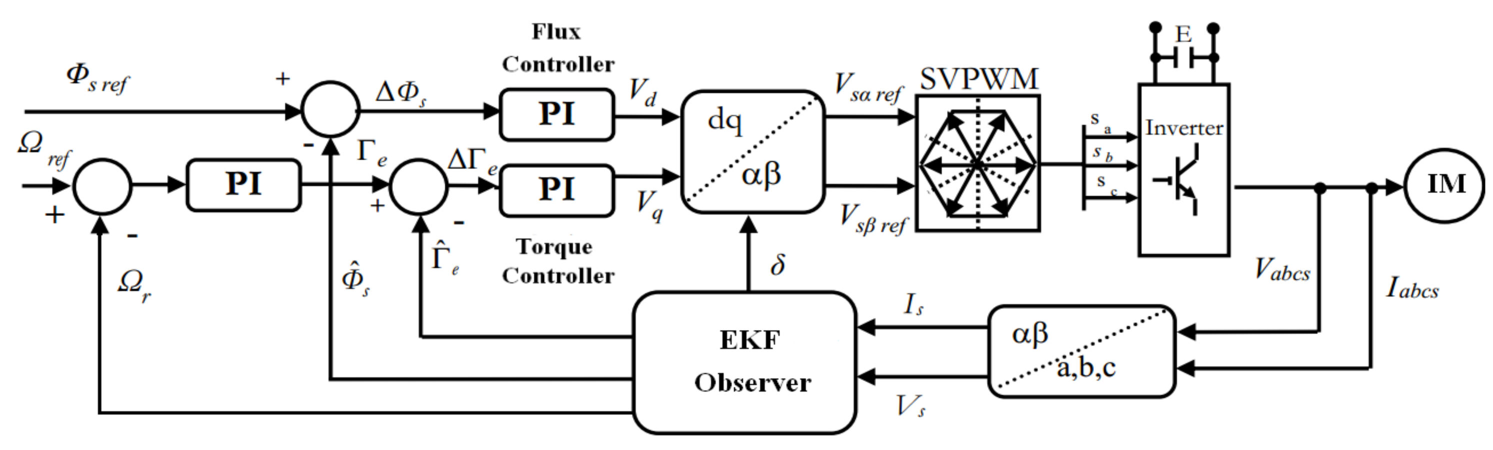

fig2. DTC of induction motor with EKF Observer

Figure 3 shows the tools used in the experimental setup.

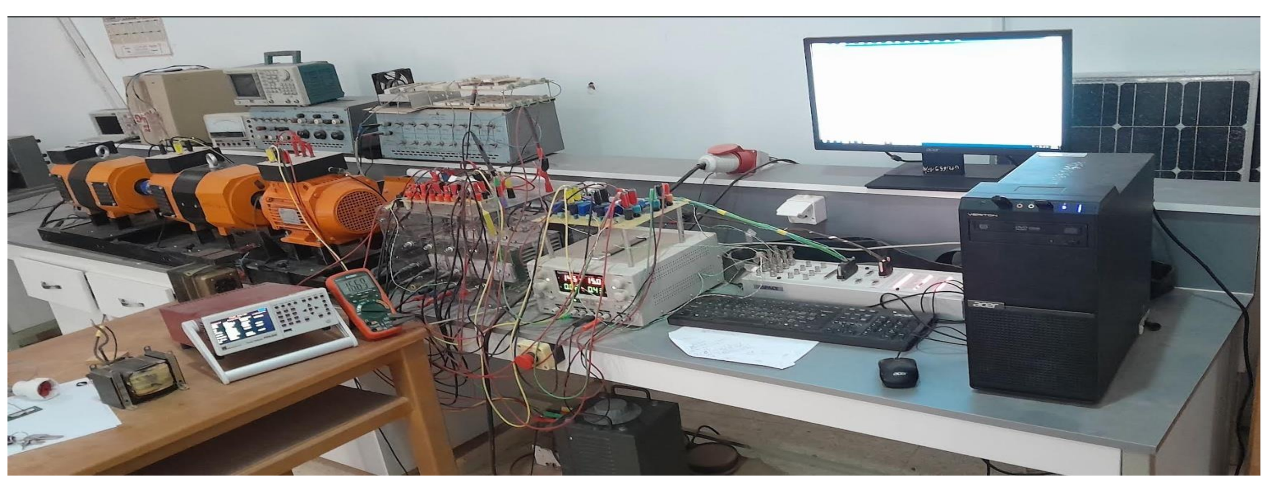

fig3. Experimental setup.

RESULTS & DISCUSSION

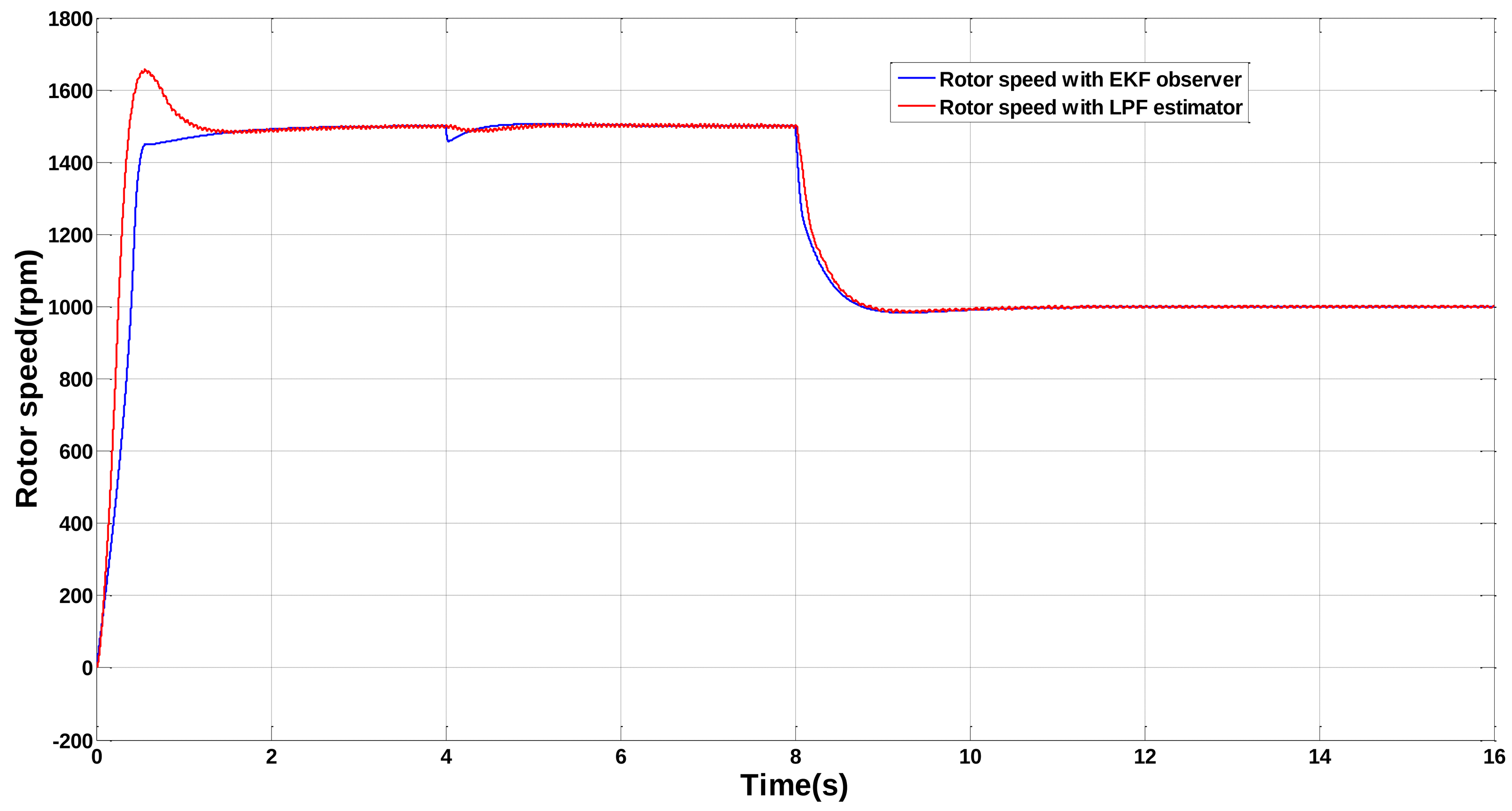

Fig4. Experiment results of rotor speed with EKF observer and LPF estimator.

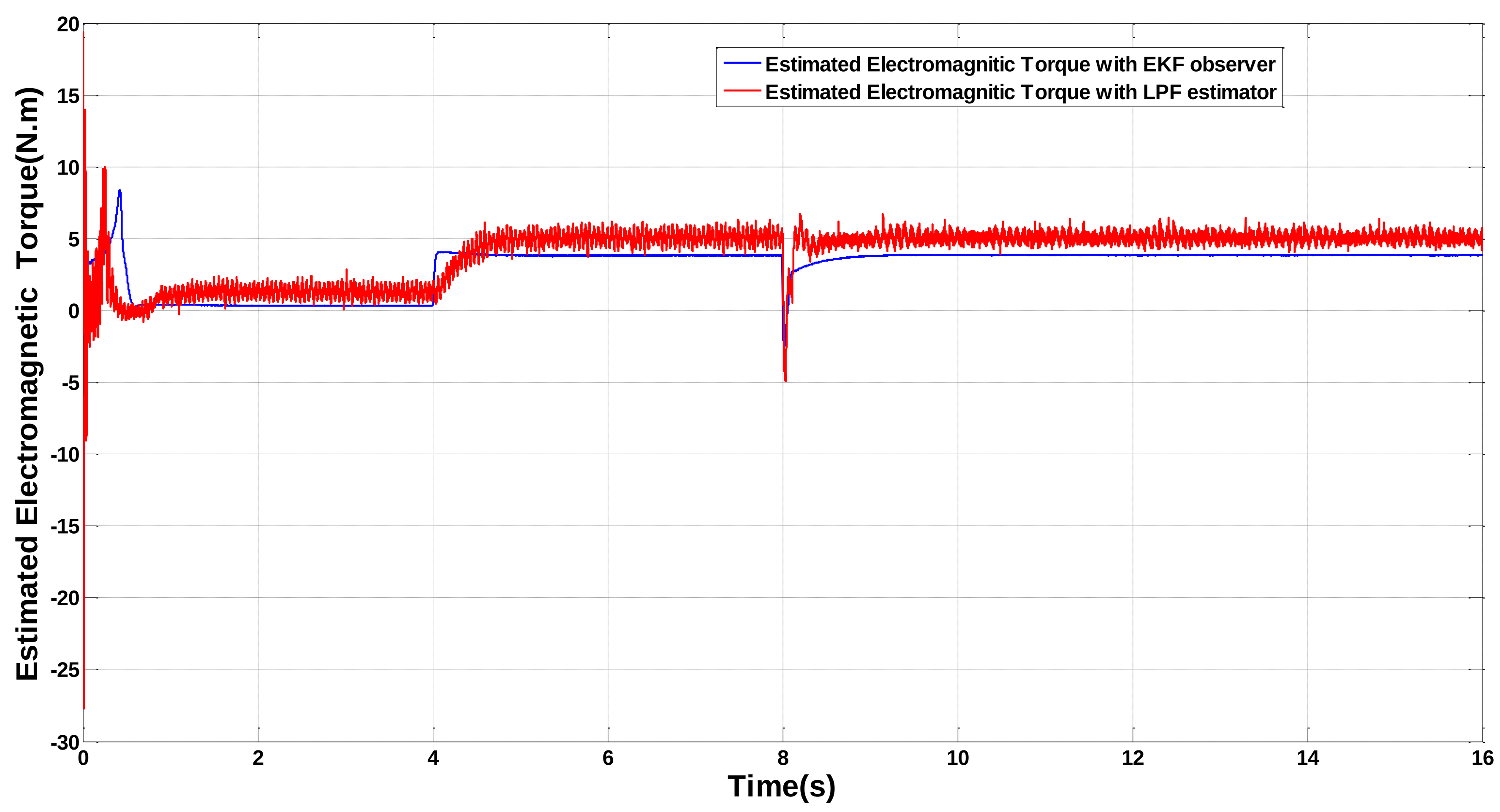

Fig5. Experiment results of Estimated Electromagnetic Torque with EKF observer and LPF estimator.

This experimental study compared the performance of EKF and open-loop estimators. The EKF demonstrated superior accuracy and robustness in estimating electromagnetic torque and rotor speed, especially in dynamic conditions and under parameter variations. While the EKF requires more computational effort, its benefits outweigh the increased complexity, making it a promising choice for high-performance DTC systems.

CONCLUSION

This study compared the performance of DTC for induction motors using EKF and open-loop estimators. The EKF demonstrated superior accuracy and robustness in estimating electromagnetic Torque and rotor speed, leading to improved dynamic response and reduced torque ripple. While the EKF requires more computational effort, its benefits outweigh the increased complexity. Future research can explore advanced EKF variants and sensor fusion techniques to further enhance performance.

FUTURE WORK / REFERENCES

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