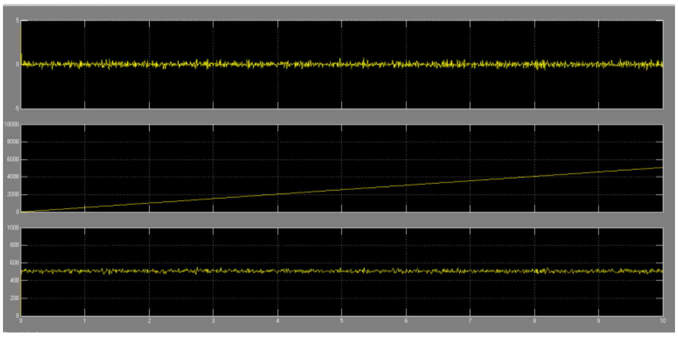

Figure 8: True states output Current and speed of DC motor

The above figure (8) shows true state output with the presence of Gaussian noise in the current output.

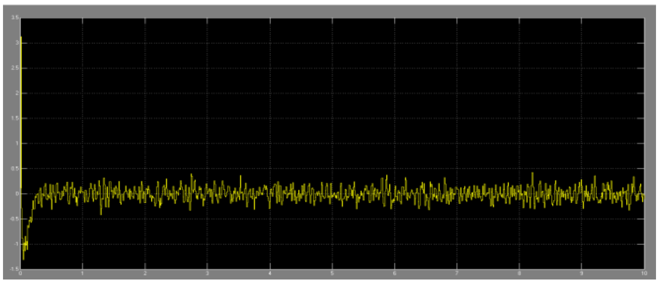

Figure 8: Difference between the healthy and faulty output

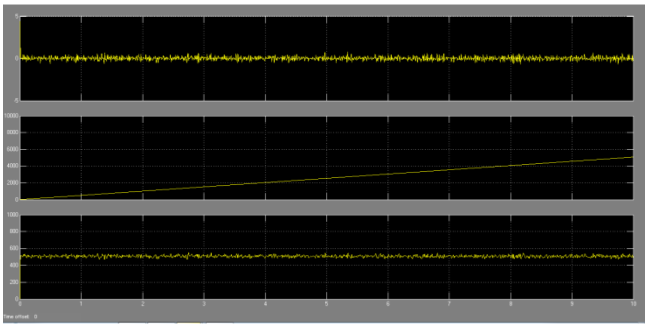

Figure 9: Estimated states output Current, speed and velocity of DC motor

4. DC Motor Parameters and Faults

Table 2 shows the different parameters with its specifications and importance. As mentioned in paper [12] the parameters such as friction coefficient and armature resistance are used to create the bearing fault and armature winding fault respectively. The increase in bearing fault is simulated by increase in the friction coefficient and the increase in armature winding fault is simulated by decrease in armature resistance.

Table 2: Importance of DC motor parameters

Parameter	Definition	Comment
K_e	Back-EMF constant	Dominate factor in determining motor's steady state speed for a given voltage
K_t	Torque Constant	Determines motor's required current for a given torque output
R_a	Terminal Resistance	Determines how much power will be dissipated in the motor for a given current level
L_a	Armature Inductance	Determines how fast current to the motor can be turned on
J	moment of inertia of the rotor	A measure of an object's resistance to changes in its rotation rate
B	Viscous (Damping) Friction	A measure of dynamic friction

Armature winding fault confirmation is modeled by varying the armature resistance of the DC motor using simulink. The output current value changes for the different values of armature resistance. The following are the results obtained for 10%, 25% variation in resistance value. When armature resistance is varied by 10% i.e. 2.266Ω and 25% i.e. 2.575Ω, current output is as shown in figure (10) and (11) respectively.

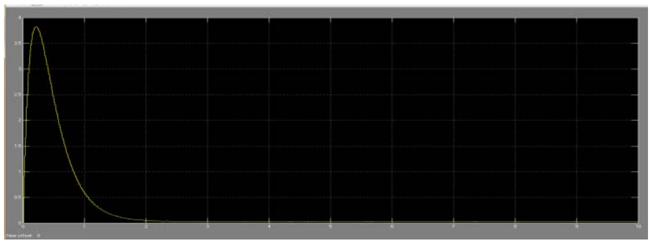

Figure 10: Current output for 10% of armature winding fault

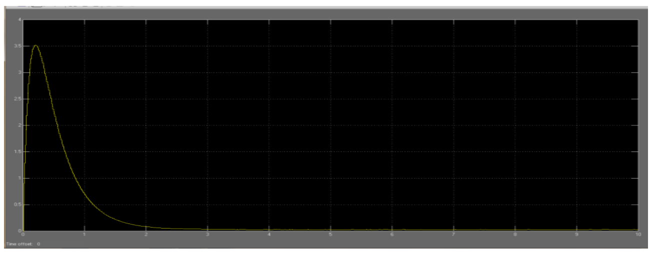

Figure 11: Current output for 25% of armature winding fault

Similarly the bearing fault confirmation is modeled by varying the value of friction coefficient of DC motor using simulink. The output current settling time varies for different values of friction coefficient. The following are the results obtained for 10%, 25% variation in the damping ratio value. When the damping ratio value is varied by 10% i.e.bm = 13.2e-7 and 25% i.e. bm=15e-7 the current response of the DC motor is as shown in figure (12) and (13) respectively.

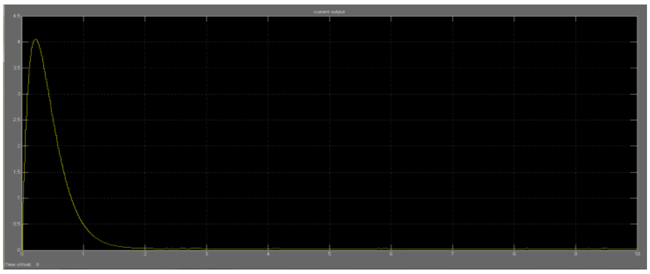

Figure 12: Current output for 10% of bearing fault

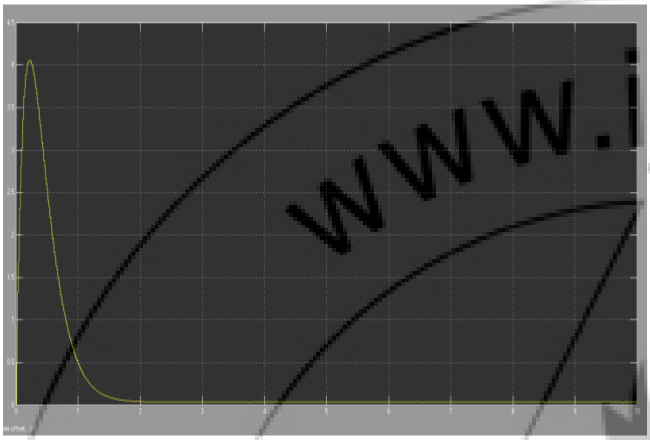

Figure 13: Current output for 25% of bearing fault

5. Conclusion

The continuous healthy operations of machines and motors are critical for the reliability of the entire system. Effective FDD can detect and diagnose abnormal conditions in time, and thus reduce the chances of catastrophic failures. In this paper a fault DC motor model design is presented for fault analysis and fault confirmation from which one can analyze the remaining useful life behavior and operation of the motor. Also a model based technique for quantification and identification of the bearing and armature winding faults in DC motor is presented in this paper. A linear iteration Kalman filter is designed for the estimations of the two states of the DC motor i.e. current and speed when noise as fault is inserted into the system. With these basic fault detection and confirmation one can diagnosis the healthy condition and operation of the motor. This method of fault detection has the advantage that it is good for measurement uncertainties. The Kalman filter has shown good performance and the other variants have not made any variations even in faulty conditions for the consider DC motor. The proposed methodology is able to quantify the level of faults in addition to identifying the fault by analyzing startup transient current from DC motor, which is different from previously proposed methodologies or expert systems that only identify the faults.

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