$$T_s = k_x(\psi_r^e - (1-k_m)\Delta\psi_r^e) * (i_s^e - (1-k_m)\Delta i_s^e + k_x(\psi_r^e + k_m\Delta\psi_r^e) * (i_s^e + k_m\Delta i_s^e) \quad (5.12)$$

$$\frac{T_s}{k_x} = 2\psi_{dr}^e i_{qs}^e + k_u(\Delta\psi_{dr}^e \Delta i_{qs}^e - \Delta i_{ds}^e \Delta\psi_{qr}^e) + k_w(\psi_{dr}^e \Delta i_{qs}^e + \Delta\psi_{dr}^e \Delta i_{qs}^e - i_{ds}^e \Delta\psi_{qr}^e) \quad (5.13)$$

The summing torque in the d-q frame is obtained by substituting equation (5.4) in the equation (5.12)

5.4 Calculation of reference current

The reference stator current expression in q-axis is obtained as follows

$$i_{qs}^{e*} = \frac{\frac{T_s}{k_x} - k_w(\psi_{dr}^e \Delta i_{qs}^e - i_{ds}^e \Delta\psi_{qr}^e) - k_u(\Delta\psi_{dr}^e \Delta i_{qs}^e - \Delta i_{ds}^e \Delta\psi_{qr}^e)}{2\psi_{dr}^e + k_{w\Delta\psi_{dr}^e}} \quad (5.$$

5.5 Weighed Value Calculations

5.5.1 Methods for weighed value calculation

The characteristics of dual induction motors fed by single inverter can be defined in two ways on the basis of the load applied to the machine.

1) Speed relevant system
2) Speed irrelevant system

5.5.1.1 Speed relevant system

In this system the speed of each motor is independent and determined by its own torque. The proportional relation of the components of these two motors will be similar thus it is enough to control the torque difference of the motors.

5.5.1.2 Speed irrelevant system

In this system the speed of each motor varies according to the unbalanced load applied to the motor. The slip with the speed of the motors is influenced by the differential torque of the motors.

5.5.2Calculation of the Weight value

The weight value $k_m$consists of two components say
1) Torque component k_{mt}
2) Speed componentk_{ms}

The components are calculated by the practical torque and speed obtained which are illustrated as

$$k_{mt} = \frac{T_1}{T_1 + T_2} \quad (5.15)$$

$$k_{ms} = k_{ms} + \text{sign}(k_{msd})d_p . k_{msd} \geq d_x$$
$$k_{ms} = k_{ms} - \text{sign}(k_{msd})d_n . k_{msd} < d_x \quad (5.16)$$

6. Results Using PI Controller

6.1 Simulation of speed control of dual IM using PI controller

The figure 6.1 depicts the simulation of vector speed control of dual induction motor implementing PI controller developed in the MATLAB.

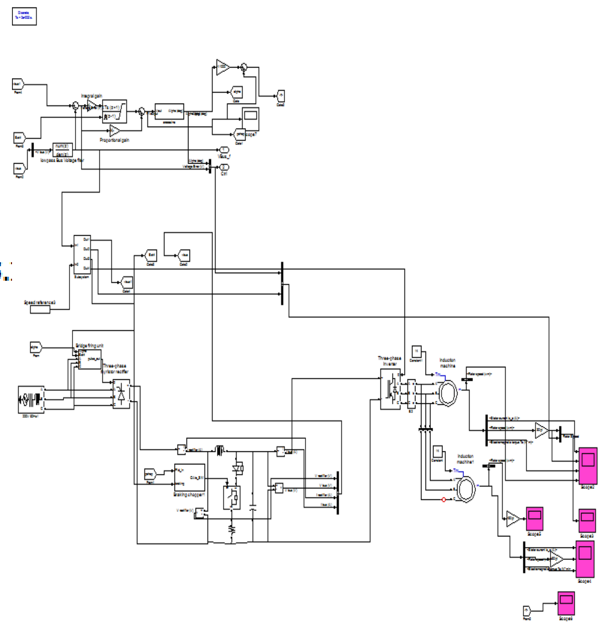

Figure 6.1: Simulation of Speed control of Dual Induction motor using PI controller

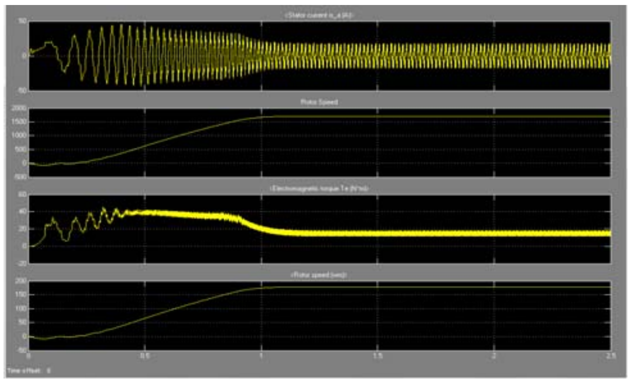

Figure 6.2: output graph obtained for motor 1

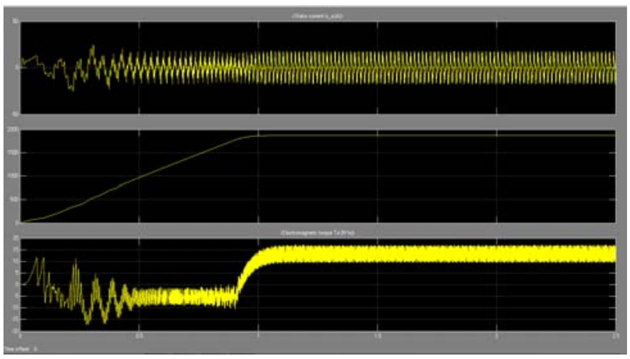

Figure 6.3: output graph obtained for motor 2

7. Results Using Fuzzy Controller

7.1 Simulation of speed control of dual IM using fuzzy controller

The figure 7.1 depicts the simulation of vector speed control of dual induction motor implementing fuzzy controller developed in the MATLAB.

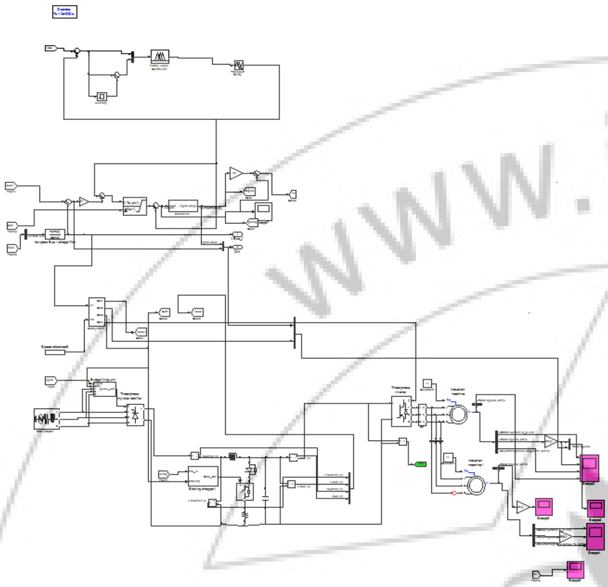

Figure 7.1: Simulation of Speed control of Dual Induction motor using fuzzy Controller

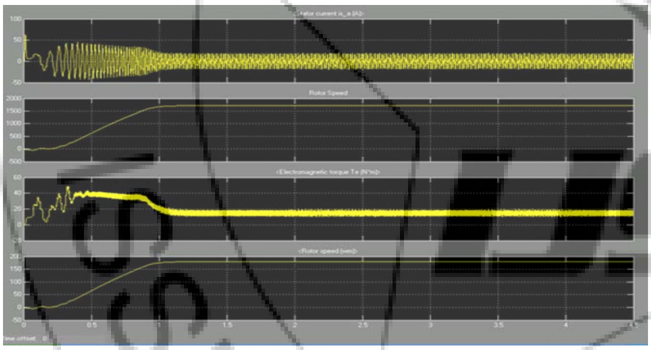

Figure 7.2: output graph obtained for motor 1

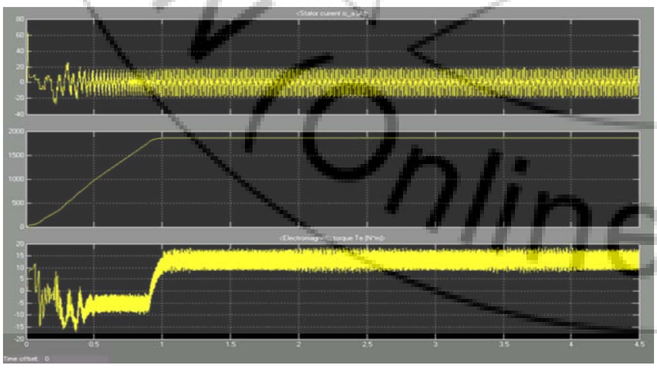

Figure 7.3: output graph obtained for motor 2

8. Inference

From the figure 6.2, 6.3 and figure 7.2, 7.3 it is clear that the starting torque is obtained well while using fuzzy controller and the harmonics is also considerably low.

9. Conclusion

In this project work, the weighed vector speed control of dual induction motor using fuzzy logic controller under unbalanced load condition is demonstrated. A frame work is developed for obtaining the weighed vector value. Modeling of induction motor is also presented.

A simulation is done in MATLAB to accomplish the weighed vector control of dual induction motor. The effectiveness of the system is analyzed through the graph achieved from the simulation. The result shows that the fuzzy logic controller is more effective than PI controller in controlling dual induction motor speed.

10. Future Scope

As a future work, the hardware of the project can be implemented and more advanced controller can be used instead of fuzzy controllers.

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