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# Using the Indirect Vector Control Method for Induction Motor Speed on Network Based Controller

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***Abstract**: The research outlines a thorough explanation along with implementation details of intelligent controllers for speed control systems of induction motors which use the indirect vector control method. A complete mathematical description and MATLAB simulation of the field orientation control (FOC) induction motor is provided for studying a 70 HP (42KW) cage type induction motor. This document evaluates the performance output of three control systems through PI fuzzy and neural networks evaluation.*
*The current method eliminates the requirement of speed and flux sensors because their installation increases expense and affects mechanical system reliability. A highly beneficial approach to achieve high-performance speed control exists through neural network-based controllers. There are three elements that comprise the system: the neural network controller and reference modal and weight adjustment methods for neural network weights permitting speed observation. The stator current functions independently from torque-producers and flux-generators in drives that use indirect vector-control of induction motors.*

***Keywords**: IVCIM NN PI, FOC, IVCIM*

## I. Introduction

An AC (alternating current) motor works without synchronization through an asynchronous design and such a device becomes known as an induction motor. The squirrel cage motor stands as the most widespread and economical choice among the different types of induction motors. Research interest in induction motor sensor-less drives has substantially grown over the past few years because of their advantages that comprise mechanical reliability combined with simpler production along with reduced need for maintenance. The technology has various applications including electricity-driven transportation for electric and hybrid automobiles and robotic systems and roller mills and wind turbines along with household appliances and heat pumps and air conditioners besides fan systems pumps paper mills trains and subway operations textile processes and industrial rolling production.

Vector control technology enhancements made induction motors the preferred choice for industrial variable speed drive systems. The method requires installation of a speed sensor such as a shaft encoder for speed control functions. The installation of speed sensors proves impossible for several operational circumstances which encompass high-speed drives and motor drives functioning in adverse environmental settings [1]. The integration of appropriate electrical cable solutions requires attention to minimize electrical disturbance. This technology increases both system expenses and motor dimensions throughout the system.

This control method presents limited performance in economic terms along with mechanical applications. Modern research focuses on "sensor less" vector control problems due to their advantages in cost savings and better dependability since they eliminate the need for rotor speed measurements. The management and estimation of ac drives proves more advanced than dc drives and becomes much more complex when demanding performance levels are necessary. This complexity stems from the combination of needs that include harmonically optimal converter power supplies with variable frequency and the intricate machine dynamics as well as changing parameters and the challenges of feedback signal processing in the presence of harmonics. Multiple factors determine the selection of drives intended for motor control.

## II. Field Orientated Control (FOC) or Vector Control

DC machines exhibit a flux alignment between their armature and field components which runs in perpendicular directions toward each other. The two opposing magnetic flows exist in perpendicular directions that generates no mutual attraction. The torque operation remains separate from flux control due to armature current adjustments while flux control depends on changes in field current. An AC machine becomes more challenging to operate because its rotor and stator fields change their orientation during various operating conditions when not maintained at 90-degrees. The orientation of stator current relative to rotor flux enables us to achieve independent flux control and torque management which produces a DC machine-like behavior for maintaining a fixed orthogonal field alignment in AC machines.

Derive high performance dynamics and ensure long-term stability through the vector or field-oriented control of cage induction motor drives which utilize closed-loop control systems. A large number of performance-driven industrial and process control applications depend on motor drives. High-performance drive systems need the motor speed to match an established reference trajectory while facing load disruptions and parameter changes as well as model errors. Field-oriented control of the induction motor (IM) drive produces superior performance outcomes. The overall system performance heavily depends on the controller design structure. Changes in the parameters of the motor reduce the decoupling properties when using vector control with IM.

## III. Control of Fuzzy Logic

Conventional control approaches are not always sufficient because automation systems are constantly evolving and small control performance criteria are becoming more demanding. However, real-world control issues are typically vague. Unknown external disruptions have the potential to alter the system's uncertain input-output relations. Such issues require the development of new plans. The use of fuzzy control is one such strategy. Fuzzy systems have gained significant use in engineering systems and consumer goods during the 1990s and 2010s since L. A. Zadeh introduced the idea of fuzzy sets in 1975 and E. H. Mamadani applied the first fuzzy controller in industry in 1974. Applications are always being presented.

This important significance can be attributed to the fact that fuzzy computing offers a versatile and potent substitute for contract controllers, supervisory blocks, computing units, and compensation systems in several application domains. Fuzzy sets make it simple to carry out nonlinear control actions. The localisation of parameters and the transparency of fuzzy rules are useful for system design and maintenance. Consequently, first outcomes can be achieved in a brief amount of time. Fuzzy logic, the foundation of fuzzy control, offers an effective way to handle precise information as the basis for reasoning. Knowledge that is expressed in an uncertain form can be transformed into a precise method using fuzzy logic. Linguistic if-then rules can be used to express the controller in fuzzy control.

## IV. Indirect Vector control of IM Model In MATLAB

Three hysteresis controllers make up the current regulator, which is constructed using Simulink blocks. The measurement output of the Asynchronous Machine block provides the motor's real currents. In a hysteresis type relay, the reference current and the actual motor currents are compared.

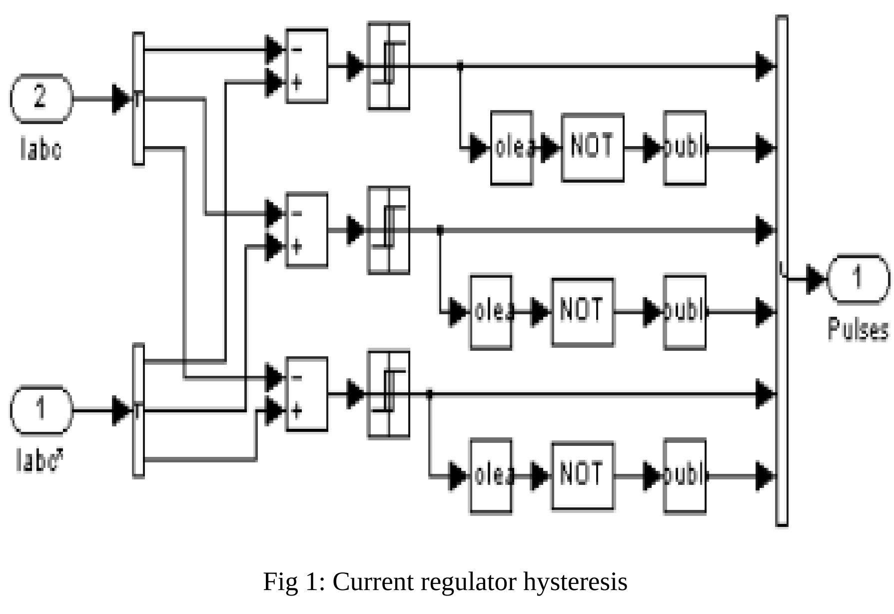


Fig 1: Current regulator hysteresis

## V. MATLAB using Predictive Controller

The NN controller differs from the PI and fuzzy controllers in this MATLAB simulation. Two inputs are taken by the NN controller: a reference input and an input plant or IM speed output.

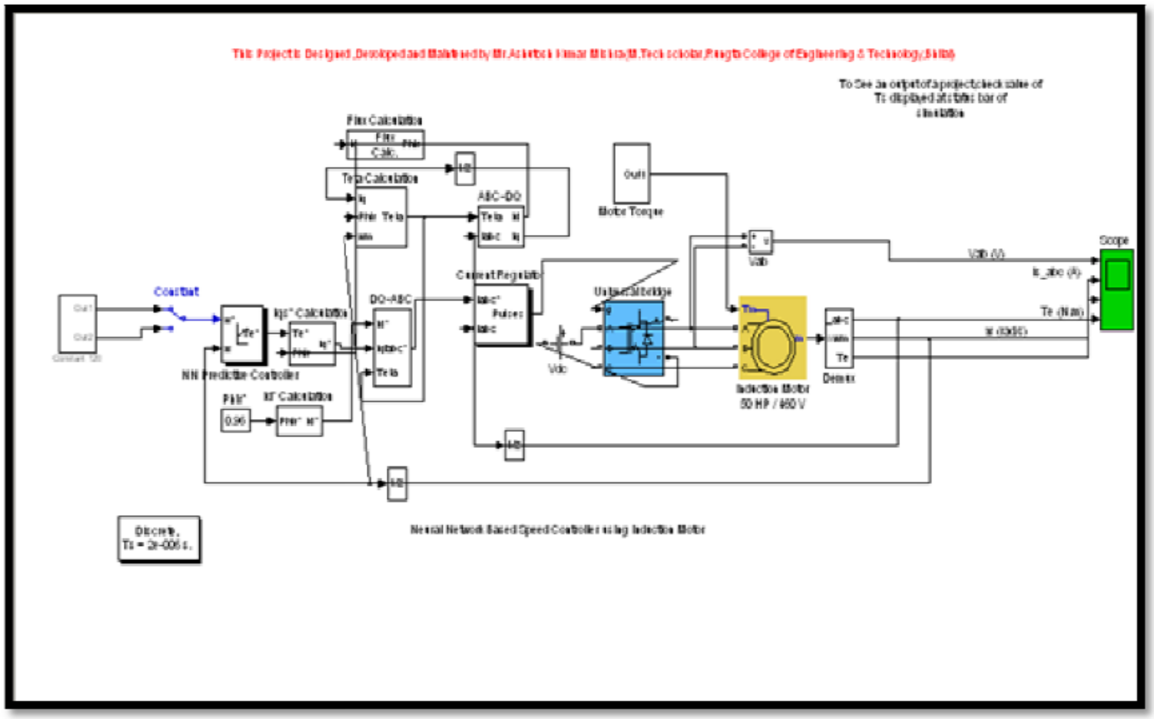


Fig 2: Matlab Simulink block diagram of indirect vector control using Neural Network controller

## VI. Conclusion

Demonstration of successful implementation has been carried out in this research using a combination of well-designed PI and fuzzy logic and neural network predictive controllers. The NN predictive controller maintains superior performance to both PI and fuzzy logic controller operations in response to load disturbances. During the performance evaluation the NN predictive controller delivered superior operating results than both PI controllers and fuzzy logic controllers under uprated motor parameters by a common factor. The NN predictive controller base outperforms fuzzy logic and PI control methods. The development required numerous attempts followed by regular adjustments leading to acceptable output results.

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