IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

Received May 27, 2021, accepted June 13, 2021, date of publication June 17, 2021, date of current version June 28, 2021.

Digital Object Identifier 10.1109/ACCESS.2021.3090254

Fuzzy Logic Control for Solar PV Fed Modular Multilevel Inverter Towards Marine Water Pumping Applications

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This work was supported in part by the Department of Science and Technology, Government of India, for the project titled, ''Design and Development of Smart Grid Architecture with Self Healing Capability Using Intelligent Control Techniques-A Smart City Perspective'' through AISTIC Scheme under Grant CRD/2018/000075.

ABSTRACT This paper presents the design and implementation of Modular Multilevel Inverter (MMI) to control the Induction Motor (IM) drive using intelligent techniques towards marine water pumping applications. The proposed inverter is of eleven levels and has the ability to control the speed of an IM drive which is fed from solar photovoltaics. It is estimated that the energy consumed by pumping schemes in an onboard ship is nearly 50% of the total energy. Considering this fact, this paper investigates and validates the proposed control design with reduced complexity intended for marine water pumping system employing an induction motor (IM) drive and MMI. The analysis of inverter is carried out with Proportional-Integral (PI) and Fuzzy Logic (FL) based controllers for improving the performance. A comparative analysis has been made with respect to better robustness in terms of peak overshoot, settling time of the controller and Total Harmonic Distortion (THD) of the inverter. Simulations are undertaken in MATLAB/Simulink and the detailed experimental implementation is conducted with Field Programmable Gate Array (FPGA). The results thus obtained are utilized to analyze the controller performance, improved inverter output voltage, reliable induction motor speed control and power quality improvement by reduction of harmonics. The novelty of the proposed control scheme is the design and integration of MMI, IM drive and intelligent controller exclusively for marine water pumping applications.

INDEX TERMS Field programmable gate array, fuzzy logic controller, induction motor drive, modular multilevel inverter, proportional-integral, total harmonic distortion.

I. INTRODUCTION

In worldwide, considerable efforts been taken by the maritime and shipping industries to deteriorate the level of atmospheric emissions and energy consumption. The deterrence of pollution in the marine environment and accidental causes are strictly followed by certain rules which are framed by International Convention for the Prevention of Pollution from Ships organization (MARPOL) [1], [2]. Due to climate change and global greenhouse gas emissions, the shipping contribute about 3% of global CO_2 emissions from diesel engines involved in marine sectors [3].

The marine shipping diesel engines emits 2.8% of Carbon dioxide (CO_2), 15% of Nitrogen Oxides (NO_X), 13% of

The associate editor coordinating the review of this manuscript and approving it for publication was N. Prabaharan.