BUMPLESS CONTROL OF PMSM FROM OPEN LOOP TO CLOSE LOOP & VICE-VERSA

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Abstract— This paper is based on bump less control from open loop to close loop and close loop to open loop for a permanent magnet synchronous motor. Sometimes an electric drive start with open loop and goes to close loop and when start with closed loop and goes to open loop a current/speed sensor fault occur. At the time of switching a transient bump is created. To reduce this type of transient a bump less algorithm will be investigated in this work. To reduce this type of transient in control system i.e. from open loop to close loop a tracking pid algorithm may be investigated. The whole model is simulated in MATLAB at the time of running from open loop to close loop and vice versa a transient bump is observed which will be reduced.

Keywords—PMSM, BUMP LESS, VVF DRIVES, PWM, CLARKE TRANSFORM, PARK TRANSFORM

I. INTRODUCTION

In recent year bump less control is used in various application like aerospace engine, compact boiler, electric vehicle. The controller switching and bump less transfer methods are applied to the problem of integrated flight and propulsion control of a future vertical/short take-off land aircraft concept [1]. The aircraft simulation model used for this study has been developed by QinetiQ (formerly the UK Defense and Evaluation Research Agency) to explore issues associated with the integration of airframe and engine control system for future V/STOL aircraft[1][2].Switching systems often appear in control practice, where several operation modes and switching between them are considered. Switching systems include the piecewise linear case, when several linear controllers are designed for a controlled plant, linearized in different operating points respective to different system modes, or cases with slow/fast controllers, changing a dynamic of system. Switching between several operation modes then introduces nonlinearity into the control loop, which may cause undesirable transient effects [3]. The suppression of these effects is called bump less transfer. Important contribution on bump less transfer in early stages was provided by Hanus, who proposed the conditioned controller to overcome transient effects when switching only the controller [4]. The off-line controller is set up to produce control signal, which ensures the tracking of reference trajectory for system in off-line mode.

II. OBJECTIVE

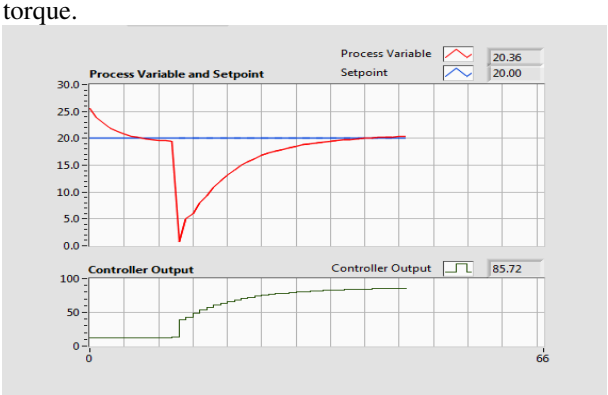
When the PMSM motor run by open loop to close loop and vice versa a transient bump is created. The objective of the proposed bump less transfer schemes are to damp oscillations in output transient response, when the new system mode is activated in switching time. New system mode may be activated using tracking PID algorithm or fuzzy based PID algorithm.

III. METHODOLOGY

When it refers to BUMPLESS TRANSFER control modes, V/F control algorithm is one of the basic control modes which is widely used in the pump and fan system. V/F is abbreviated from voltage/frequency. V/F control is an induction motor control method which ensures the output voltage proportional with the frequency, so it maintains a constant motor flux, preventing weak magnetic and magnetic saturation phenomenon from happening. V/F control principle is to produce a circuit called voltage-controller oscillator with oscillator frequency. It is a voltage-dependent capacitance, when subjected to a change in voltage, its capacity will change, and then the change in capacity will cause changes in the oscillation frequency, resulting in variable_frequency. This controlled frequency is used to control the frequency of the output voltage, in order to achieve speed changes of the controlled electric motors. At a rated frequency, if voltage is set to a certain value and only reduce the frequency, then there will be large magnetic flux and magnetic circuit saturation (severely, it will burn motor). Therefore, the frequency and voltage must be changed proportionally. When changing the frequency, we should control the output voltage of AC drive, in order to keep constant flux and avoid weak magnetic and magnetic saturation phenomenon. This control method is commonly applied for fans and pumps. The flux of the motor is governed by the stator voltage and frequency. The variation in one parameter will lead to an increase/decrease of stator flux that deteriorates the performance of an induction motor. Therefore, it is important to keep the ratio of voltage and frequency constant throughout the speed regulation in VVFds **(Variable voltage variable frequency drives).** In order to keep the magnetic flux constant, the constant ratio of V/F is maintained by

PWM (**Pulse width modulation**) inverter**.** The application in which high starting torque is required can be met by keeping the V/F ratio higher than the rated flux of the motor during

acceleration of the motor. This is known as the "starting torque Boosting" feature of the drive. Once the motor gets accelerated, the drive keeps V/ f ratio constant to deliver rated torque.

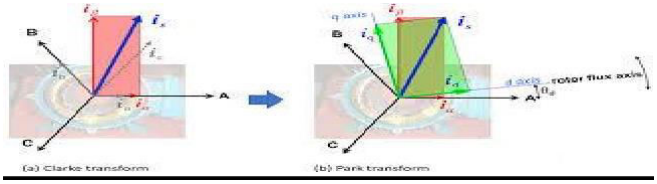


output of v/f control

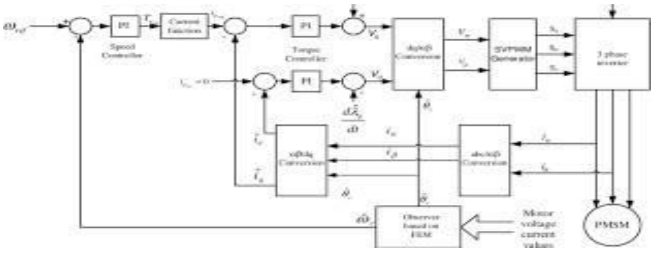
The PMSM Field-Oriented Control block implements a field-oriented control structure for a permanent magnet synchronous machine (PMSM). Field Oriented Control (FOC) is a performant AC motor control strategy that decouples torque and flux by transforming the stationary phase currents to a rotating frame. Use FOC when rotor speed and position are known and your application requires:

- High torque and low current at startup.
- High efficiency

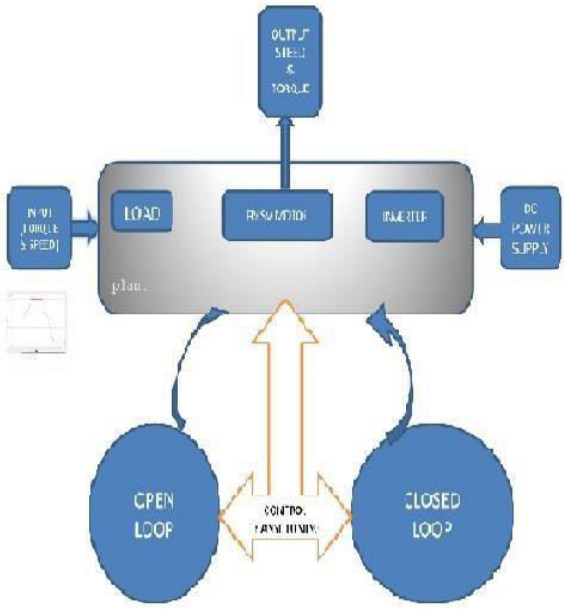
In FOC, the components Iq and Id are referenced to the rotating reference frame. Hence the measured stator currents have to be transformed from the three-phase time variant stator reference frame to the two-axis rotating dq rotor reference frame. This can be done in two steps as shown in Figure.



The transformation from the 3-phase 120-degree reference frame to two axis orthogonal reference frame is known as **Clarke transform**. Similarly, the transformation from two axis orthogonal reference frame to the two-axis rotating reference frame is known as **Park transform.**

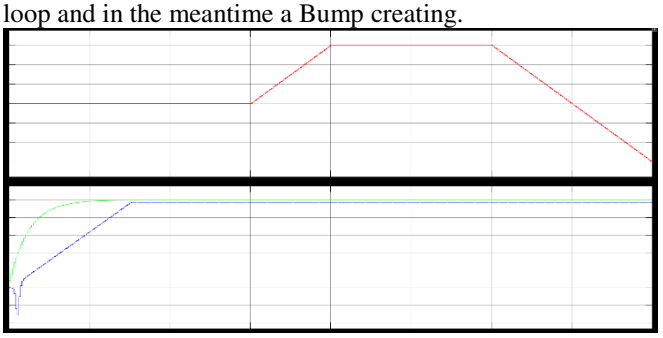


(**field-oriented control of permanent magnet synchronous machine**)

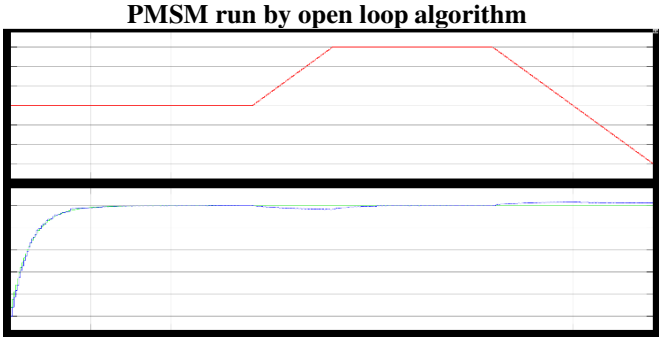


block diagram of bump less control of PMSM

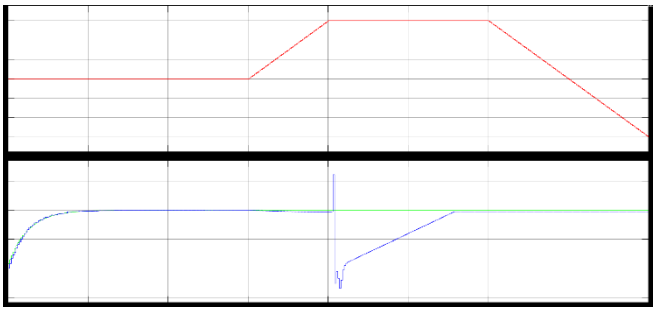
For Bump less control of pmsm here inputs are torque and speed. Torque is given to the load, from load to PMSM motor and to run the motor connect an inverter. Then give a dc power supply to the plant. Now 1st the plant run by open loop algorithm and see the characteristic. 2nd the plant run by closed loop algorithm and see the characteristics. After it by switching algorithm run the plant by closed loop and open loop and in the meantime a Bump creating.



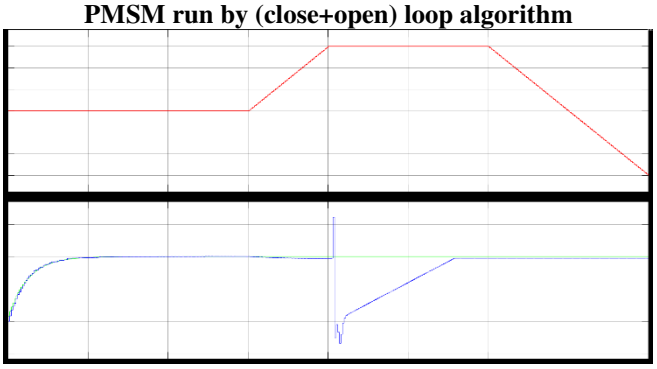
PMSM run by open loop algorithm



PMSM run by close loop algorithm



PMSM run by (close+open) loop algorithm



PMSM run by (open+close) loop algorithm

IV. FUTURE WORK

The whole model is simulated in MATLAB, at the time of running from open loop to close loop and vice versa a transient bump is observed which will be reduced by some algorithm.

V. CONCLUTION

- The main objective of the paper is to propose bump less transfer (BT) applicable for switched nonlinear systems
- The developed BT schemes are applied for a discrete time switched system with v/f and F.O.C controllers
- Simulation results demonstrate the effectiveness of bump less transfer method. Because the method makes use only of knowledge of the switched controllers.

REFERENCES

[1] T. C. S. Wibowo, N. Saad, and M. N. Karsiti, "System identification of an interacting series process for real-time model predictive control," in 2009 American Control Conference, Saint Louis, Missouri, USA, 2009.

[2] Bates, D. G., Gatley, S. L., Postlethwaite, I., and Berry, A. J. Design and piloted simulation of a robust integrated flight and propulsion controller. Am. Inst. Aeronaut. Astonaut. J. Guidance, Control and Dynamics, 2000, 23(2), 269–277

[3] Cheong, S.Y., and Safonov, M.G. (2008). Bumpless transfer for adaptive switching controls. Proceedings of the IFAC World Congress 2008

[4] Hanus, R. (1988). Anti-windup and bumpless transfer: a survey. In Proc. 12th IMACS World Congr. on Scientific Computing, Paris, pp. 59–65