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Robust Constrained Model Predictive Voltage Control Scheme and its Classification

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Abstract. *In this study, a prospective power system is suggested (PPS), predictive current control (PCC), enhanced voltage control (EVC), model predictive control (MPC), induction motor (IM) circuit. Instead of monitoring the torque and speed as in conventional MP DTC, the stator voltage is directly regulated in the suggested PVC model thanks to the predictive control theory. A voltage source inverter's use of a model predictive control approach. For all potential voltage vectors produced by the inverter, this method forecasting value of the load using a discrete model of the system. "Voltage-source converter based high voltage direct current (VSC-HVDC)" connected offshore wind farms using a "model predictive control (MPC)" based Enhanced Voltage Control Strategy (EVCS) (OWFs). All wind farm generator (WTGs) and wind farm side VSCs are effectively synchronized in the proposed Midi controller EVCS to maintain voltages within a practical range and reduce system power loss. Review of induction motor defects, including mechanical and insulating issues. The summary of static current signature of machine failures. Numerous useful feature extraction techniques have been introduced for induction motor problem detection.*

Key words: *wind farm generator, high voltage direct current,*

1. INTRODUCTION

The anticipated output current determines the forecast voltage in the proposed method, therefore there are actually two prediction steps: the output current prediction comes first, then the voltage prediction. It makes up for the impacts of load uncertainty. As a result, it is appropriate for all types of loads, including balanced, unbalanced, and non-linear loads. Any research on the creation of such algorithms has been done. " Predictive Current Control (PCC)" techniques stand out among them because they perform a great deal better than more traditional techniques like vector control and direct torque control (DTC). The primary goals of PCC are to accurately control the simultaneous stator currents in the shortest amount of time possible. The load torque and the torque deflection are roughly proportionate. An induction motor's characteristics are typically simply approximations, and they always change depending on the operating environment. For instance, the majority of applications do not require exact knowledge of induction generator specifications due to temperature change.

2. PREDICTIVE VOLTAGE CONTROL SCHEME

Figure 1 depicts the suggested model "predictive voltage control" strategy. Based on the measured current and voltage at k, this method predicts the voltage output vector for a predetermined time horizon of k + N using the intrinsic specific of the four-leg inverters and RLC filter, and chooses a switching state by minimizing the cost (quality) functions for each sampling time.

Discrete-Time Predictive Control Model: The anticipated voltage output vectors vo[k + N] in binary format is necessary for the cost function. Due to this, the spatial systems in (9) could be written as follows in discrete time:

$$\begin{bmatrix} \mathbf{v_o}[k+N] \\ \mathbf{i}\,[k+N] \end{bmatrix} = \mathbf{\Phi} \begin{bmatrix} \mathbf{v_o}[k+N-1] \\ \mathbf{i}\,[k+N-1] \end{bmatrix} + \mathbf{\Gamma} \begin{bmatrix} \mathbf{v}[k+N-1] \\ \mathbf{i_o}[k+N-1] \end{bmatrix}$$

Where,

$$\mathbf{\Phi} = e^{T_s A}, \quad \mathbf{\Gamma} = \mathbf{A}^{-1}(\mathbf{\Phi} - \mathbf{I_{2x2}})\mathbf{B},$$

$$\mathbf{\Phi} = \begin{bmatrix} \phi_{11} & \phi_{12} \\ \phi_{21} & \phi_{22} \end{bmatrix} = \begin{bmatrix} 1-\cos(q) & p\sin(q) \\ (1/p)\sin q & \cos(q) \end{bmatrix},$$

$$\mathbf{\Gamma} = \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix} = \begin{bmatrix} \cos(q) & -p\sin(q) \\ -(1/p)\sin q & 1-\cos(q) \end{bmatrix},$$

Where,

$$p = \sqrt{\frac{L_f}{C_f}}, \quad q = \frac{T_s}{\sqrt{L_f C_f}}.$$

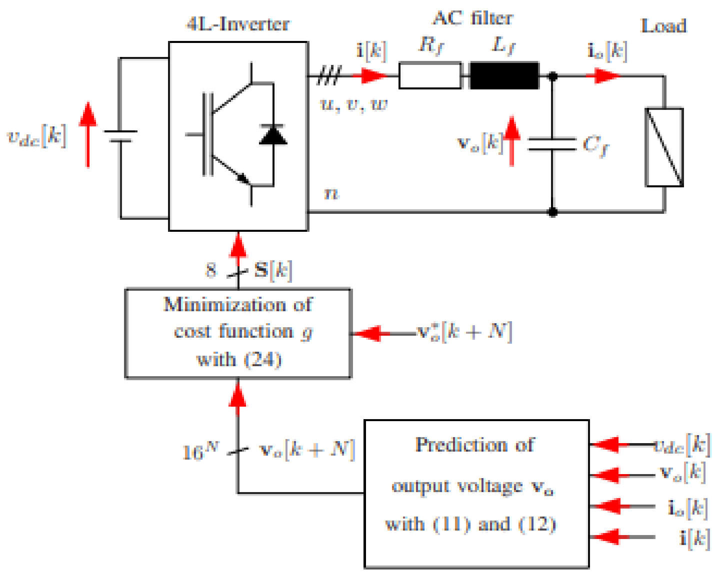

FIGURE 1. Block diagram of model predictive voltage control scheme for the four-leg inverter

In a real-world scenario, any item on the bus may be requested to be connected or disconnected at any time by a user. "Model predictive control (MPC)", "maximum sensitivities selection", and parallel processing techniques are used to study and solve a very complex and unpredictable system that is created by modelling all potential demands. These (centralized or distributed) approaches for static arrays models fail to take into consideration how the state dimensions changes when PEVs are plugged in and out. The proposed system, in contrast, solely simulates the network's stable state and manages plug-in requests when fresh loads demand provisioning. Contrary to the majority of the results, the suggested controller is based on reconfiguration each time a new load is attached rather than flexible load forecasting. Local load voltage and overall load shaping are two distinct purposes and time scales that the controller must take into account. Prior research advocated multilevel, multi-horizontal systems, and decentralized protocols, but did not take into account distribution system control devices that are already in use.

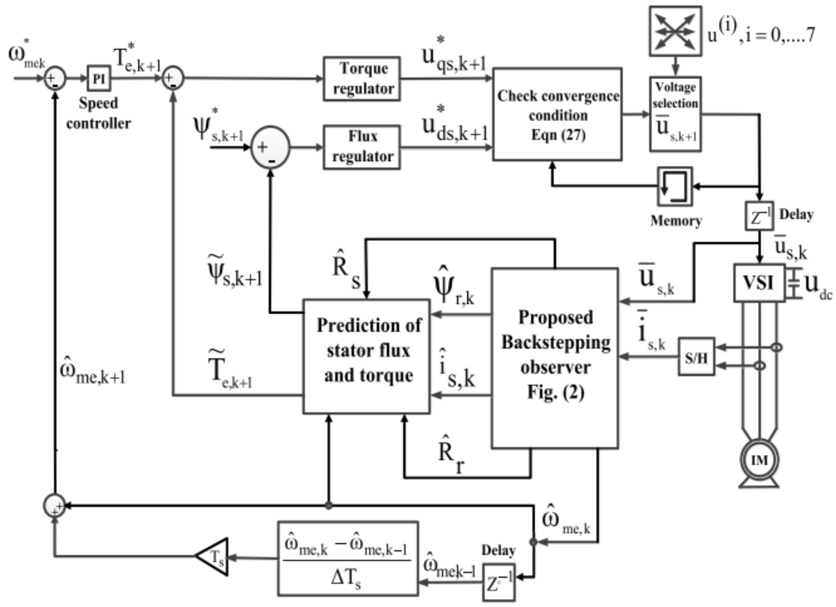

FIGURE 2. Proposed sensor less PVC approach for IM drive

Currently, it is thought that predictive control (PC) is a viable solution for enhancing the dynamics of "induction machine (IM) drives". The administered in the form that make up the PC technique are categorized using the cost function form. As an example, MP DTC was taken into account, where the error reducing equation included flux and torque errors and employed a weighting factor to manage the effect of two factors against one another. The stator current's alpha-beta (-) or straightforward (d-q) components were divided into two equal halves for the error function in predictive current control (PCC).In order to simulate the BSO, the following relationships can be used.

$$
\begin{aligned}
\frac{d\hat{\psi}_{\alpha r}}{dt} &= -\frac{\hat{R}_r}{L_r}\hat{\psi}_{\alpha r} - \hat{\omega}_{me}\hat{\psi}_{\beta r} + \frac{\hat{R}_r L_m}{L_r} h_\alpha \\
\frac{d\hat{\psi}_{\beta r}}{dt} &= -\frac{\hat{R}_r}{L_r}\hat{\psi}_{\beta r} + \hat{\omega}_{me}\hat{\psi}_{\alpha r} + \frac{\hat{R}_r L_m}{L_r} h_\beta \\
\frac{d\hat{i}_{\alpha s}}{dt} &= \frac{\hat{R}_r L_m}{\sigma L_s L_r^2}\hat{\psi}_{\alpha r} + \frac{L_m}{\sigma L_s L_r}\hat{\omega}_{me}\hat{\psi}_{\beta r} \\
&\quad - \frac{L_m^2 \hat{R}_r + L_r^2 \hat{R}_s}{\sigma L_s L_r^2} h_\alpha + \frac{1}{\sigma L_s} u_{\alpha s} + s_\alpha \\
\frac{d\hat{i}_{\beta s}}{dt} &= \frac{\hat{R}_r L_m}{\sigma L_s L_r^2}\hat{\psi}_{\beta r} - \frac{L_m}{\sigma L_s L_r}\hat{\omega}_{me}\hat{\psi}_{\alpha r} \\
&\quad - \frac{L_m^2 \hat{R}_r + L_r^2 \hat{R}_s}{\sigma L_s L_r^2} h_\beta + \frac{1}{\sigma L_s} u_{\beta s} + s_\beta
\end{aligned}
$$

where the inputs for the control that will be created using the home safely technique are s and s.

3. PREDICTIVE CURRENT CONTROL (PCC)

A fixed power converter can only produce a finite number of switching states, and models of the systems can be used to forecast the behavior of the parameters for each power switch. This is the foundation of the suggested predictive control technique. A selection criterion needs to be established before the proper transition state can be used. The quality function used to represent this specific condition is assessed for the calculated return of the control factors. For each potential transition state, a forecasting of the potential price of these different factors is calculated. The goodness function is minimized by selecting a transition state. the load voltage used to control the predictive current. With this control method, the predictive controller produces the command signal for the switches without the use of a modulator. FCS-MPC, on the other hand, uses a load model and the inverter's intrinsic discrete characteristic to address the optimization problem. Finite Control Set "Predictive Torque Control" (PDC) and Infinite Control Set "Predictive Current Control" are the two versions of FCS-MBC utilized in power electronics (PCC). The two limited control approaches' major plan is to support the internal Conventional pi controller and PWM blocks set with a predictive thrust controller, which will lead to faster dynamics.

4. INDUCTION MOTOR (IM) CIRCUIT

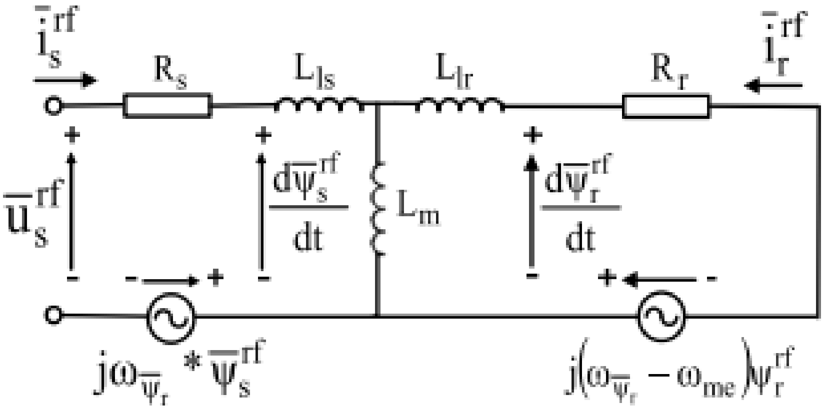

FIGURE 1. Model Induction Motor (IM) Circuit

The frequency is shown by $\omega_{me} = p\omega_m$, where m is the electromechanical speed and p represents the pole pairs. All variables are reported to be presented in a frame that is synchronized with the estimated rotor vector by the superscript 'rf'. The stator voltage, stator current and stator flux vectors are represented by $\bar{i}_s^{rf}$ and $\bar{\psi}_s^{rf}$ consecutively. While the rotor flux and current vectors are defined by $\bar{\psi}_r^{rf}$ and $\bar{i}_r^{rf}$ respectively. Using the model in Fig. 1, the electric dynamics of IM can be described by the following expressions.

$$\frac{d\bar{\psi}^{rf}_{s,k}}{dt} = \bar{u}^{rf}_{s,k} - R_s\bar{i}^{rf}_{s,k} - j\omega_{\bar{\psi}_r}\bar{\psi}^{rf}_{s,k} \qquad (1)$$

$$\frac{d\bar{\psi}^{rf}_{r,k}}{dt} = -R_r\bar{i}^{rf}_{r,k} - j\left(\overbrace{\omega_{\bar{\psi}_{r,k}} - \omega_{me,k}}^{\omega_{slip,k}}\right)\bar{\psi}^{rf}_{r,k} \qquad (2)$$

$$\frac{d\omega_{me,k}}{dt} = \frac{p}{J}\left(T_{e,k} - T_{l,k}\right) \qquad (3)$$

where, $T_{e,k}$ and $T_{l,k}$ are the motor and load torques, respectively. J is referring to the motor's inertia. The motor's torque $T_{e,k}$ can be evaluated using the cross product of the fluxes by

$$T_{e,k} = 1.5p\frac{L_m}{\sigma L_s L_r}\bar{\psi}_{s,k} \times \bar{\psi}_{r,k} \qquad (4)$$

The flux vectors in (4) can be represented exponentially as follows

$$\bar{\psi}_{s,k} = \left|\bar{\psi}_{s,k}\right| e^{j\omega_{\bar{\psi}_{s,k}}t}, \text{ and } \bar{\psi}_{r,k} = \left|\bar{\psi}_{r,k}\right| e^{j\omega_{\bar{\psi}_{r,k}}t} \qquad (5)$$

Line current or typical current harmonics increase when a failure happens. Thus, the normal operating zone and the fault operational region can be used to split the regional transportation of an induction generator. As a result, the motor's operating modes can be divided into two categories: normal production modes and faulty modes. It is simple to comprehend that the line harmonics will vary depending on the load conditions (speed, torque).

However, based on their statistical behavior, the functional endpoints can be divided into various groupings. These collections of feature vectors F with various statistics are referred to as functional patterns.

5. CONCLUSION

This study suggests an induction motor (IM) circuit with prediction voltage regulation (PVC), predictive current controller (PCC), enhanced voltage regulation (EVC), and model predictive control (MPC). Due to its simplicity, adaptability to the quirks of electronic devices, and use in power electronic applications, Finite Control Set Trajectory Tracking Control (FCS-MPC) has recently attracted increased attention. FCS-MPC can regulate the inverter without a modulation step and doesn't need any parameter adjustment, in contrast to standard control approaches like PID and PR control methods. This control method stays clear of common control issues including windup and disconnecting variables. Common Induction Motor Mechanical Faults These errors have corresponding signatures that have been introduced. The methods for identifying defects based on symptoms are compiled. Review of the inverter-fed inductive motor drive system diagnostics.

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