Research Article

Improve MPPT in Organic Photovoltaics with Chaos-Based Nonlinear MPC

Mohammad Mahdi Borhan Elmi, Osman Yildirim

Abstract—**Environmental pollution, climate changes such as melting of natural glaciers and rising sea levels are only instances of the challenges of using fossil fuels. Therefore, increasing use of clean renewable energy sources such as photovoltaic systems has a great importance. In this paper, the chaotic-based nonlinear model predictive control approach is used for extracting the maximum power of organic photovoltaic cells, which has not only a suitable tracking speed but also in fault conditions, can be useful to improve the operation level of the distribution network. This approach is a feedback-based recursive control strategy which capable of predict the proper operating state that minimizes its cost function. The proposed approach consists of two stages of estimating the reference point and regulating the operatimg point according to it. In this regard, the Lagrange function is used for managing the performance of the estimator and chaotic neural network model predictive controller to control the operation of boost converter. By using the chaos-based nonlinear model predictive controller, the amount of overvoltage is reduced by more than 1.3%. In fact, without using of control methods, the voltage range exceeds its allowable values with increasing of the OPV panels penetration. According to the obtained results, with the reduction of network losses, the capacity of distribution feeders is increased and the level of system efficiency is also improved.**

Index Terms—**Chaos Theory, Model predictive controller, MPP tracking, Nonlinear MPC, Organic Photovoltaic.**

I. INTRODUCTION

IN THE past years, the capacity of photovoltaic (PV) systems used in the power system has grown significantly. According to the report of the European Photovoltaic Industry Association (EPIA), the amount of installed PV system capacity has increased to about 345 GW by 2020 [1]. With the increase in the penetration of clean renewable sources, there are concerns about their effect on power quality indices, reliability, stability against possible faults and network losses [2].

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For instance, a sudden drop in the voltage level can activate the islanding mode and lead to the isolation of PV systems from the main grid. In fact, an adaptive control model not only can reduce power quality problems but also provide a reliable performance for transient stability [3]. Although the traditional methods for controlling the performance of solar arrays have a simple implementation, they have disadvantages such as slow tracking, continuous fluctuations even when reaching the maximum power point (MPP), low efficiency and lack of proper control in the transient states [4]. In [5-6] the angle of incremental conductance with type-2 fuzzy was combined to transfer the maximum power under long-term weather conditions such as broken clouds. Also, in [7] the adaptive type-2 fuzzy neural network (AT2FNN) was applied to EN 50530 test procedure system to extract maximum power under dynamic performance of the PV generation systems. According to the literature review, model predictive controller (MPC) based MPPT methods present a unique performance that increases operational efficiency and improves the speed of convergence for tracking the reference point [8] (Table I).

In [9], the MPC as a model-based control method has achieved remarkable success in industrial applications, especially in variable working conditions and the presence of limitations. In addition, these approaches have a fast dynamic response. This controller has been improved in recent decades. A brief overview of MPC applications can be found in [10]. However, at the presence of severe variations in the environmental conditions and undesired disturbances, using a linear model for approximation can not provide the proper efficiency. So, the non-linear model can be used to provide a better mapping between the current conditions and the desired outputs. Also, using of chaos theory is increasing the speed of convergence with improving the exploring ability in search space. Among the most important contributions of the proposed paper, the following can be mentioned:

- Designing an innovative chaotic-based nonlinear MPC (CNMPC) approach to control the switching process of the converter from organic solar arrays for operating at MPP with considering variable environmental conditions, network load changes and unwanted disturbances.
- Prediction of converter performance during fault occurrence in order to improve stability
- Using the chaos-based neural network to improve the quality of the reference point tracking
- Implementation of the proposed approach on the organic PVs as a new generation of solar panels with 100% recycling capability.

In the rest of the article, first, details about organic PVs, nonlinear model preictive controller, chaos-based systems are presented. Then the characteristics of the proposed approach include how to generate reference values, the designed process for regulating the operating point of the converter, The mathematical model of organic PV and Boost converter is stated and the objective function is expressed. Finally, the obtained results are presented in the form of figures and after evaluating the efficiency of the proposed approach, the conclusion is stated.

II. Basic Concepts

A. Organic Photovoltaic

Organic Photovoltaic (OPV) technology has several advantages compared to silicon-based PV, including light weight, semi-transparency, high-flexibility, cheaper and simpler production process with low energy consumption, the possibility of OPV production through 3D printing on flexible substrates at low temperature, the ability to mount on flexible surfaces [11], using in indoor and outdoor environments and full recyclability (100%) [12].

An OPV cell consists of an absorber-receiver layer connected to transmission layers. Electrical contacts are used on both sides of the absorbent layers. This layer absorbs the incoming photons and if the energy absorbed from the electrons is greater than their band gap, excitation occurs. This excitability causes the occurrence of current between the layers [13]. The specifications of the different models are compared with each other in Table II.

TABLE II
COMPARISON OF ORGANIC PV CHARACTERISTICS

Model	No. of Parameters	Complexity	Ref.
One Diode	5	Low	[14]
Two Diodes	7	Medium	[15]
Two Inverted Diodes	8	Medium	[16]

B. Nonlinear Model Predictive Controller

Although the traditional methods have a simple implementation, they have disadvantages such as slow tracking, constant fluctuations even when reaching the maximum power point, and low efficiency. In this regard, several solutions have been proposed to overcome the above challenges. But these methods, unlike linear systems modeling methods, did not provide a specific method to identify the system. Recently, researchers, inspired by the human brain, presented neural networks to model nonlinear, uncertain and complex systems [17]. Among the nonlinear models, neural networks are the required model for control due to the feature of high non-linear adaptation can provide the forecast appropriately. In this project, the NMPC approach will be used, which has several advantages, some of which are as follows:

- The ability to explore precisely among various operating states of the system
- Providing the necessary flexibility to control complex systems
- Improving the level of system stability during disturbances

C. Chaotic systems

Chaos is a fundamental concept in modern science, which is observed in many phenomena of the real world, including systems with apparently random and disorderly behavior, as well as systems with definite behavior. The main essence of chaos theory is that there is order in every disorder. In the sense that order should not be sought on a small scale. Excessive sensitivity to initial conditions and having a continuous frequency spectrum are special characteristics of the dynamic behavior of chaotic systems [17]. In recent years, random value generation has been combined with chaotic mappings to use their better dynamic and statistical properties. Indeed, chaotic mapping is applied in the main structure of these proposed algorithms in order to improve the process of generating random numbers for improving the exploring capability.

TABLE I
COMPARISON OF DIFFERENT MPPT METHODS

Mppt Method	Speed	Accuracy	Sensor Type	Cost	Status	Complexity	Characteristic
VOC	Medium	Low	Voltage	Low	Offline	Simple	Linear
ISC	Medium	Low	Current	Low	Offline	Simple	Linear
P&O	Medium	Medium	Voltage Current	High	Online	Simple	Linear
INC	High	Good	Voltage Current	High	Online	Medium	Linear
ANN	High	Medium	Voltage Current	High	Online	Complex	Non-linear
Fuzzy	Medium	Medium	Voltage Current	Low	Online	Complex	Non-linear
MPC	High	Medium	Voltage Current	Low	Online	Simple	Linear

III. Problem Modelling

Due to the non-linearity of the I-V characteristic of the PV curve resulting from variation of irridiation, temperature and other effective factors, tracking the maximum power point would be a challenging task. In this regard, perturb and observe (P&O) or incremental conductivity (IC) methods have been used to generate reference values. However, these two methods can not capable to track severe changes in the environmental conditions properly. Also, the generated power of these methods fluctuates at its steady state point, which increase the amount of power loss. The strategy of the proposed approach is separated into two stages of estimating the reference point for each time step and adjusting the operating point of the converter

A. Generation of reference values

In MPC techniques, discrete equations of the system are used to predict the future state of the controlled variable. In the case of the solar array, designing an accurate model of the system at each time step is a very challenging task due to the presence of various effective factors that change continuously. Among these factors, variable solar irradiations, sudden temperature changes, and erosion of PV modules can be mentioned. In order to improve the performance efficiency, a predictor model with Lagrange polynomial transform function is used to model the P-V curve whose characteristics are stated in Equation 1. Also, the Vandermonde matrix also is used to determine the values of the coefficients, which are defined according to Eq. (1) [18]. These coefficients are updated at each sample step to obtain an accurate estimation for the P-V curve in any weather condition. In fact, it is necessary to model the variations of environmental conditions continuously in predictor model. Then the obtained points are applied to the control system for tracking. In this paper, the logistic map is used to improve the search process of extracting the global optimal point. In this mapping, a second-order polynomial function is used according to Eq. (3). In this relation, r is the control parameter ($0 \le r \le 4$) and x_0 is the initial value ($0 \le x_0 \le 1$).

$$v_{pv}(k) = a_2 . i(k)_{pv}^2 + a_1 .\ i_{pv}(k) + a_0 \tag{1}$$

$$\begin{bmatrix} i(k-2)_{pv}^2 & i_{pv}(k-2) & 1 \\ i(k-1)_{pv}^2 & i_{pv}(k-1) & 1 \\ i(k)_{pv}^2 & i_{pv}(k) & 1 \end{bmatrix} \begin{bmatrix} a_2 \\ a_1 \\ a_0 \end{bmatrix} = \begin{bmatrix} v_{pv}(k-2) \\ v_{pv}(k-1) \\ v_{pv}(k) \end{bmatrix} \tag{2}$$

$$x_{k+1} = r . x_k (1 - x_k) \tag{3}$$

B. Regulating the operating point

In this project, the combination of chaotic neural network with non-linear MPC system is used to track the reference values according to the conditions created in each time step and received values from predictor model. Neural networks has the ability to produce dynamic responses in a suitable time frame, which has made it possible to use them in systems with severe changes. In this project, the Boost converter is used to achieve high voltage gain, and the dynamic model of the converter's behavior is described by Eq. (4) to Eq. (5). In these equations, s indicates the switching mode, $v_c(t)$ is the capacitor voltage and $v_{pv}(t)$ is the PV array voltage.

In other words, the control process in the proposed CNMPC controller as shown in Fig. 1 can be described as follows:

- Determining the reference for active/reactive powers by the upper hand control level
- Calculation of the reference current of the controller
- Determination of predicted current
- Apply two currents to the cost function
- Testing the values in the cost function and choosing the desired voltage value as the controller voltage reference
- Calculation of switching times

$$L \frac{di_L}{dt}(t) = -(1-s) v_c(t) + v_{pv}(t) \tag{4}$$

$$C \frac{dv_c}{dt}(t) = (1-s) i_L(t) + \frac{1}{R} v_c(t) \tag{5}$$

C. Organic PV model

In recent years, several models such as single diode, two and three diode models have been introduced for organic PV cells [19]. Although single-diode and double-diode models are commonly used to model silicon PV cells, they can not provide proper results for describing the behavior of organic cells. So, the model of two inverted diodes is used for this purpose (Fig. 2). The related equations are stated in Eq. (6) to Eq. (10). The current-voltage characteristic of the organic PV is described by Lambert W function. In these equations, V_{D1} and V_{D2} indicate the voltage of diode D_1 and D_2, respectively.

$$V_{D1} = V - IR_s - V_{D2} \tag{6}$$

$$I = \frac{1}{R_s + R_{sH1} + R_{sH2}} [-(I_{ir} + I_{D1}) R_s + (I_{D2} . R_{sH2}) - V] \tag{7}$$

$$V_{D2} = (I - I_{D2}) . R_{sH2} \tag{8}$$

$$I_{D1} = I_{o1} \left[e^{\frac{V - IR_S - V_{D2}}{n_1 V_T}} - 1 \right] \tag{9}$$

$$I_{D2} = I_{o2} \left[e^{\frac{V_{D2}}{n_2 V_T}} - 1 \right] \tag{10}$$

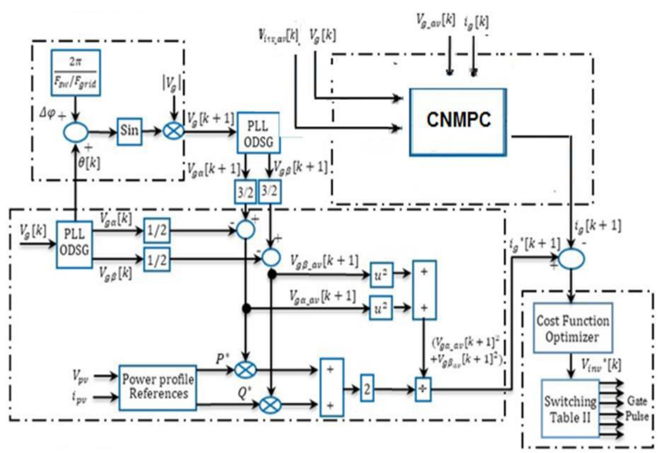

Fig.1. The structure of proposed approach

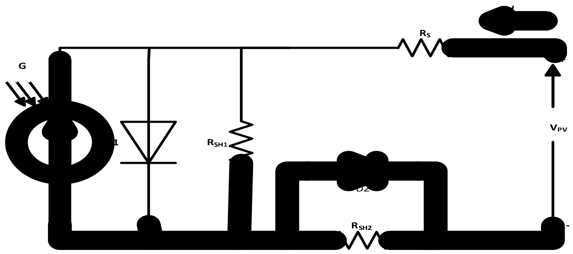

Fig.2. Two diode model of organic PV [20]

D. Boost Converter Model

A boost converter is a step-up converter that is usually used to convert voltage from low levels to higher levels. The schematic of this converter is shown in Fig. 3. In order to extract the maximum power at each time step, the designed signal commands are applied to this converter. In this project, a discrete-time model is used for modelling of the converter. In this regard, the inductor current is estimated for the next time step and then the obtained results are evaluated. According to the designed model, Eq. (11) and Eq. (12) are presented the ON state and Eq. (13) and Eq. (14) are presented the OFF state of the converter.

$$i_{pv}(k+1) = i_{pv}(k) + \frac{T_s}{L}\left(v_{pv}(k) - v_c(k)\right) \tag{11}$$

$$v_c(k+1) = \left[1 - \frac{T}{RC}\right] v_c(k) + \frac{T_s}{C}\left(i_{pv}(k)\right) \tag{12}$$

$$i_{pv}(k+1) = i_{pv}(k) + \frac{T_s}{L}\left(v_{pv}(k)\right) \tag{13}$$

$$v_c(k+1) = \left[1 - \frac{T}{RC}\right] v_c(k) \tag{14}$$

IV. Objective Function

In the proposed approach, at the first stage, the voltage and current values of the reference operating point are estimated by model predictor according to the intensity level, ambient temperature, dynamic variations of load and other effecting factors. Then, the switching pattern of the converter is determined by using the chaos-based nonlinear predictive controller.

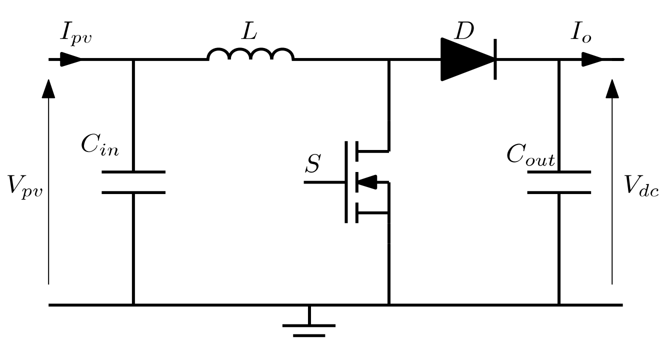

Fig.3. Schematic of boost converter [21]

The steps of the proposed approach are as follows:

- Measuring the current/voltage of the panel and sending it to the control unit
- Calculation of current and voltage variations according to Eq. (15) and Eq. (16).
- Calculation of the reference voltage by using predictor model (Eq. (17))
- Regulating the duty cycle of converter (Eq. (18))

Eq. (18) shows the objective function, which tries to minimize the difference between the current/voltage of the operating point with reference ones in each time step.

$$\frac{di_L}{dt} = \frac{v_{pv}}{L} - \frac{v_o}{L} \tag{15}$$

$$\frac{dv_{pv}}{dt} = -\frac{i_L}{C_1} + \frac{i_{pv}}{C_1} \tag{16}$$

$$\frac{dv_o}{dt} = \frac{i_L}{C_2} - \frac{v_o}{RC_2} \tag{17}$$

$$\min O.F = W_A.\left|V_o(k+1) - V_{MPP}\right|^2 + W_B.\left|i_o(k+1) - i_{MPP}\right|^2 \tag{18}$$

V. Simulation Results

In order to evaluate the proposed controller approach, the simulation was done in MATLAB/Simulink environment (Fig. 4.)

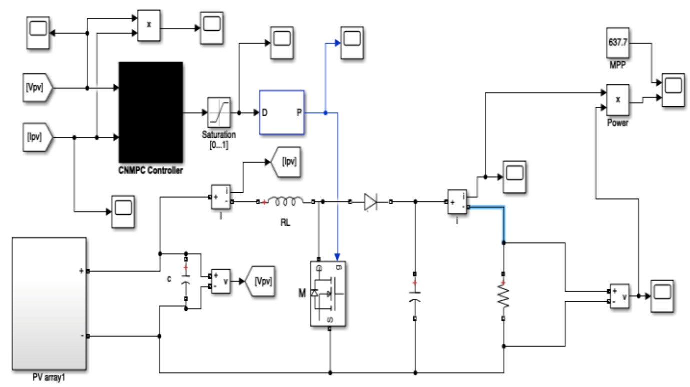

Fig.4. Simulink model of under study system

V.1 Performance evaluation during disturbances

When one of the modules receives less light due to several reasons such as dust and shading, the voltage at that point drops. In this situation, the mentioned point acts as a generator, which is known as a hotspot. Normally, in this situation, a bypass diode is used in parallel with each of the OPV modules to protect the module. In addition, a blocking diode is used at the end of each string (combination of series modules in a current path) to prevent reverse current caused by voltage mismatch between parallel strings. The voltage profile in these conditions is shown in Fig. 5.

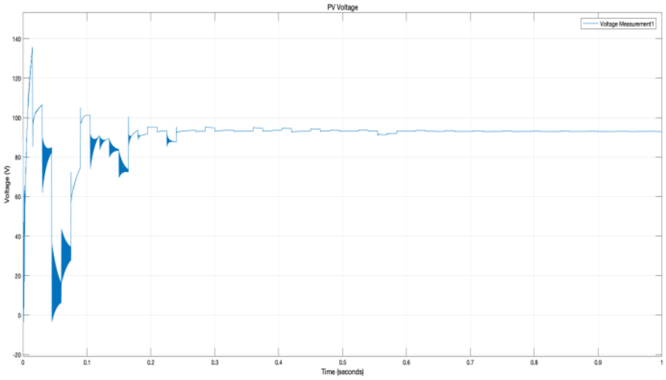

Fig.5. Output voltage of OPV panel (With considering disturbance)

The output signal of PWM modulator and the output power of the controller as well as reference current are shown in Fig. 6 and Fig. 7, respectively.

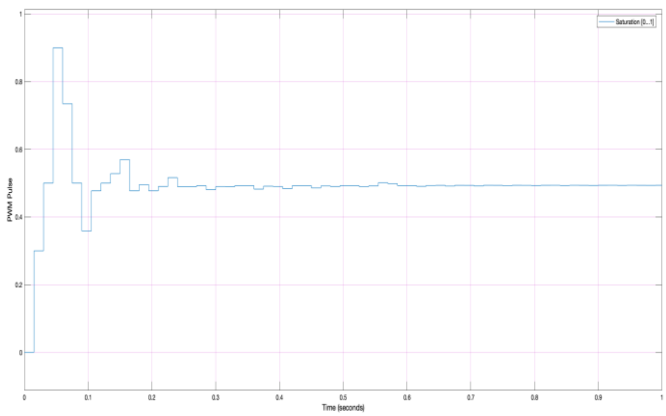

Fig.6. Output signal of PWM converter

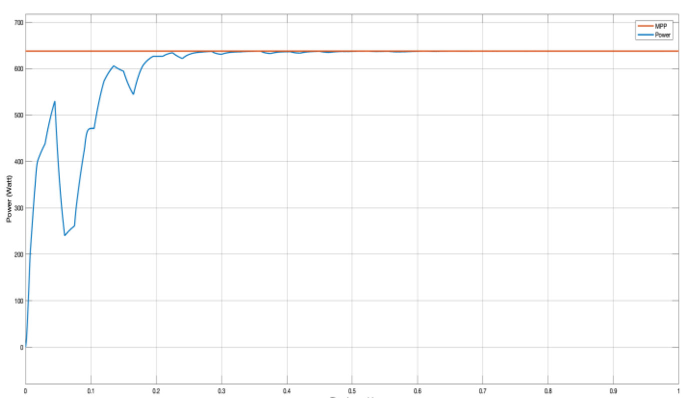

Fig.7. Tracking the desired output power

In order to tracking the desired values, a 100s time interval is considered. In the first 25s, the reference signal has a value of 1 p.u. and then in the period of 25s to 50s, the value of the amplitude is increased to 2 p.u. then in the period between 50s and 75s is decreased to -1 p.u. Finally, is converged to 0 p.u. The results of using the linear MPC shows that when the desired value changes, the tracking signal consists of significant undershoots and overshoots, which are reduced when the nonlinear MPC control method is used (Fig. 8).

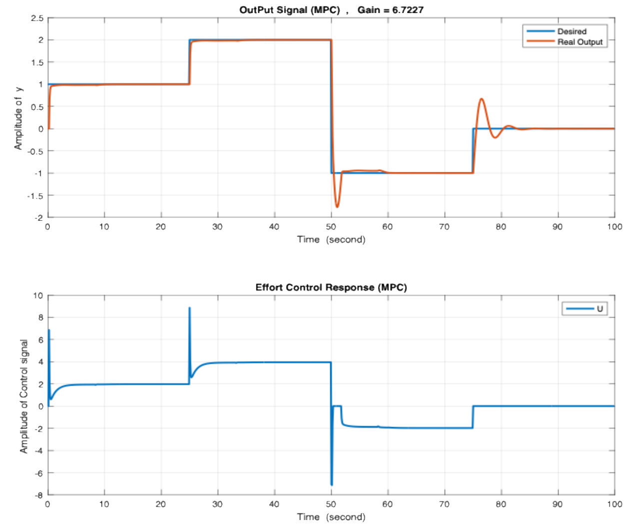

Fig.8. Linear MPC control method

(Top: Tracking of desired output – Bottom: Variation of control signal)

The output signal obtained from the implementation of the nonlinear MPC approach and the chaos-based nonlinear MPC approach are also shown in Fig. 9 and Fig. 10, respectively. As it is shown from the results, in the linear MPC, the rate of convergence of the output signal insists of severe variations, but by using the nonlinear MPC approach and chaos-based non-linear MPC, this is greatly reduced and lead to faster convergence. The output power of the controller in two states (real output and reference mode) is shown in Fig. 8. In this situation, it can be seen that tracking has been done properly using the proposed approach.

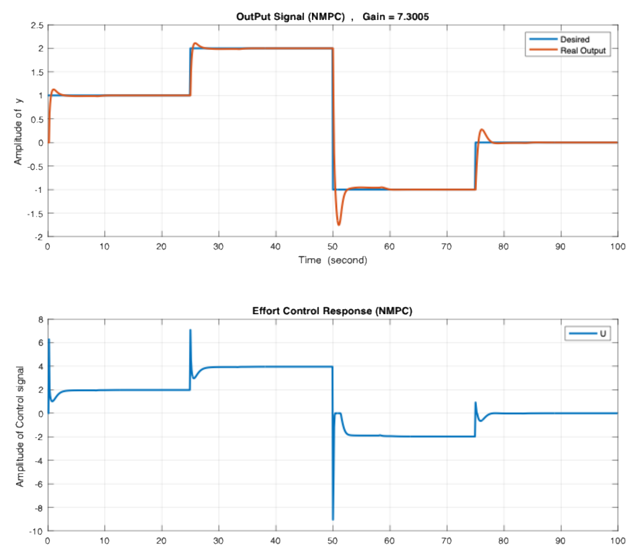

Fig.9. Non-linear MPC control method

(Top: Tracking of desired output – Bottom: Variation of control signal)

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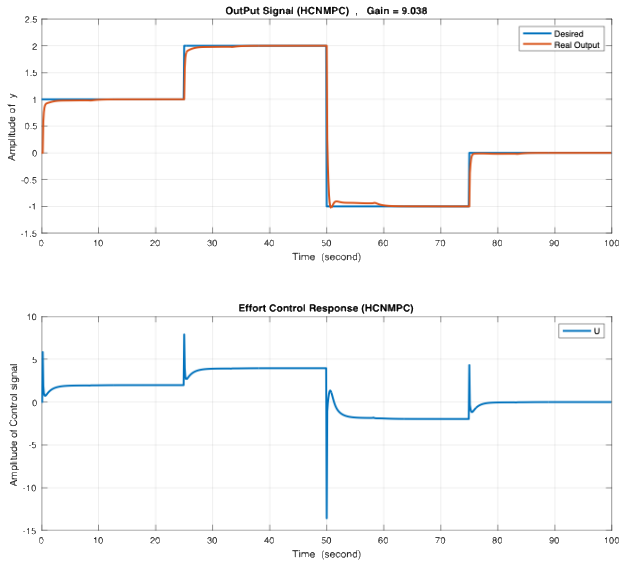

Fig.10. Chaos-based Non-linear MPC control method

(Top: Tracking of desired output – Bottom: Variation of control signal)

V.2 Results comparison

In this section, the numerical results obtained by using different methods are compared with each other. As can be seen in Table. 3, by using the CNMPC, the amount of overvoltage is reduced by more than 1.3%. In fact, without using of control methods, the voltage range exceeds its allowable values with increasing of the OPV panels penetration.

TABLE III
COMPARISON OF VOLTAGE PROFILES (P.U.)

Status	Phase 1	Phase 2	Phase 3
Without using OPV arrays	0.985	0.984	0.983
OPV arrays + P&O controller	1.024	1.035	1.017
OPV arrays + CNMPC controller	1.010	1.002	1.005

VI. CONCLUSION

Reactive power injection can be used to restore voltage drop in distribution networks. In this paper, the constant peak current adjustment method is used to protect the converter system against overcurrent and if the voltage reduction is less than 50%, all injected power will be converted into reactive power. In other words, although the function of the MPPT controller is to provide the maximum power that can be extracted from the solar panels, but in the fault duration, the reference values for active and reactive power is estimated by predictor model and the operation of the converter is controlled by chaos-based NMPC controller. Indeed, the strategy of the proposed approach is divided into two stages, the estimation of the reference point in each time step and the adjustment of the operating point of the converter in order to extract the maximum power. In this regard, the Lagrange polynomial tarnsform function was used to model the power-voltage curve predictor, whose coefficients are updated at each sampling step. Also, the combination of chaotic neural network with NMPC system has been used to track the reference values according to the dynamic conditions of environment. In addition, the modeling of the control approach has been done on organic solar panels, which are not only fully recyclable, but also have a higher efficiency than the silicon-based PV cells.

REFERENCES

[1] Menna, P., R. Gambi, T. Howes, W. Gillett, G. Tondi, F. Belloni, P. De Bonis, and M. Getsiou. "European Photovoltaic Actions and Programmes-2011”." *EU PVSEEC* (2011).

[2] Razavi, Ali Bannae, and Mohammad Mahdi Borhan Elmi. "Improvement of Voltage Profiles in Mashhad Distribution Systemwith Presence of Rooftop PV." In *2020 10th Smart Grid Conference (SGC)*, pp. 1-6. IEEE, 2020.

[3] Borhan, Elmi Mohammad Mahdi, Hamed Lotfi, and Amir Hossein Lotfi. "Economic-environmental evaluation of using green energy resources with considering pollution limitations." (2023).

[4] Bouaouaou, Hemza, Djaafer Lalili, and Nasserdine Boudjerda. "Model predictive control and ANN-based MPPT for a multi-level grid-connected photovoltaic inverter." *Electrical Engineering* 104, no. 3 (2022): 1229-1246.

[5] Gani, Ahmet, and Mustafa Sekkeli. "Experimental evaluation of type-2 fuzzy logic controller adapted to real environmental conditions for maximum power point tracking of solar energy systems." *International Journal of Circuit Theory and Applications* 50, no. 11 (2022): 4131-4145.

[6] Kececioglu, O. Fatih, Ahmet Gani, and Mustafa Sekkeli. "Design and hardware implementation based on hybrid structure for MPPT of PV system using an interval type-2 TSK fuzzy logic controller." *Energies* 13, no. 7 (2020): 1842.

[7] Gani, Ahmet. "Improving dynamic efficiency of photovoltaic generation systems using adaptive type 2 fuzzy-neural network via EN 50530 test procedure." *International Journal of Circuit Theory and Applications* 49, no. 11 (2021): 3922-3940.

[8] Derbeli, Mohamed, Cristian Napole, Oscar Barambones, Jesus Sanchez, Isidro Calvo, and Pablo Fernández-Bustamante. "Maximum power point tracking techniques for photovoltaic panel: A review and experimental applications." *Energies* 14, no. 22 (2021): 7806.

[9] Abdel-Rahim, Omar, and Haoyu Wang. "A new high gain DC-DC converter with model-predictive-control based MPPT technique for photovoltaic systems." *CPSS Transactions on Power Electronics and Applications* 5, no. 2 (2020): 191-200.

[10] Rampradesh, T., and C. Christober Asir Rajan. "Performance assessment of NMPC based MPPT controller and extended Kalman filter for a Wind/PV hybrid system." In *2021 Fourth International Conference on Electrical, Computer and Communication Technologies (ICECCT)*, pp. 1-4. IEEE, 2021.

[11] Välimäki, Marja K., Laura I. Sokka, Heidi B. Peltola, Sami S. Ihme, Teijo MJ Rokkonen, Timo J. Kurkela, Jyrki T. Ollila, Arttu T. Korhonen, and Jukka T. Hast. "Printed and hybrid integrated electronics using bio-based and recycled materials—increasing sustainability with greener materials and technologies." *The International Journal of Advanced Manufacturing Technology* 111 (2020): 325-339.

[12] Piccoli, Emanuele, Alessandro Dama, Alberto Dolara, and Sonia Leva. "Experimental validation of a model for PV systems under partial shading for building integrated applications." *Solar Energy* 183 (2019): 356-370.

[13] Mei, Hongkun, Chunjuan Jia, Jun Fu, and Xiaoming Luan. "Low voltage ride through control strategy for MMC photovoltaic system based on model predictive control." *International Journal of Electrical Power & Energy Systems*125 (2021): 106530.

[14] Mehta, Hitesh K., Himanshu Warke, Kaushik Kukadiya, and Ashish K. Panchal. "Accurate expressions for single-diode-model solar cell parameterization." *IEEE Journal of Photovoltaics* 9, no. 3 (2019): 803-810.

[15] Hejri, Mohammad, Hossein Mokhtari, Mohammad Reza Azizian, Mehrdad Ghandhari, and Lennart Söder. "On the parameter extraction of a five-parameter double-diode model of photovoltaic cells and modules." *IEEE Journal of Photovoltaics* 4, no. 3 (2014): 915-923.

[16] Moliton, André, and Jean-Michel Nunzi. "How to model the behaviour of organic photovoltaic cells." *Polymer International*55, no. 6 (2006): 583-600.

[17] Tahir, Furqan, and Imad M. Jaimoukha. "Robust feedback model predictive control of constrained uncertain systems." *Journal of Process Control* 23, no. 2 (2013): 189-200.

[18] Pecora, Louis M., and Thomas L. Carroll. "Synchronization in chaotic systems." *Physical review letters* 64, no. 8 (1990): 821.

[19] Liu, Zhijian, Zhao Jin, Guiqiang Li, Xudong Zhao, and Ali Badiei. "Study on the performance of a novel photovoltaic/thermal system combining photocatalytic and organic photovoltaic cells." *Energy Conversion and Management* 251 (2022): 114967.

[20] Uvais, Mohd, Asif Jamil Ansari, and Mohammed Asim. "Modeling and Analysis of Organic Solar Cells Using Multiple Diodes." In *2022 2nd International Conference on Emerging Frontiers in Electrical and Electronic Technologies (ICEFEET)*, pp. 1-5. IEEE, 2022.

[21] Meddour, Sami, Djamel Rahem, Ali Yahia Cherif, Walid Hachelfi, and Laib Hichem. "A novel approach for PV system based on metaheuristic algorithm connected to the grid using FS-MPC controller." *Energy Procedia* 162 (2019): 57-66.

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Osman Yildirim has received two PhD, one is in the field of Engineering, one is in the field of Business Management, specifically in Human Resources Management. He has international journal papers in both disciplines. He has been dealing with OHSAS for a long time by teaching the OHSAS training courses and giving consultancy in OHSAS to companies. He has both trainer certificate and consultant certificate which are accredited by Turkish Employee Ministry. He is currently working with Istanbul Aydin University, Istanbul, Turkey.