

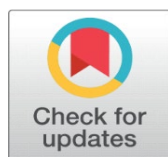
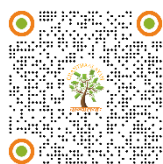
AN EFFICIENT OPTIMIZED MPPT FOR PV SYSTEM UNDER EXTREMELY FAST CHANGING IRRADIANCE – HYBRID HONEY BADGER OPTIMIZER

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ABSTRACT

In closing a long time, renewable power means have entered lesser hobbyhorse as the choice for of strength is growing. Solar power is truly the maximum functional salutary useful resource in the fineness of renewable powers as it's long hauls to be had transnational. Solar energy can be converted into energy in approaches; via CSP energy factory life or Photovoltaic structures. The solar energy is converted to lukewarmness and also this energy is converted to energy in CSP energy shops. Still, this revision of power can be finished in an unattached- step system by the use of sun panels and PV period. This generation is fantastically trusted sun irradiance and temperature. For every particular 2d, there can be a maximum electricity aspect (MPP) and its charge is reckoned on irradiance and temperature. The conventional strategies cannot perform sufficiently. Metaheuristic optimization algorithms may be used to song MPP in every normal circumstance and partial shading script. The pivotal gain of the use of them is that they will be speedy in operation, and they don't trap in near optimums. This oil uses Honey Badger Optimization set of rules in Maximum Power Tracking (MPPT) in PV systems.

Keywords: Solar Energy, HBO System, MPPT Software and MATLAB Simulation

1. INTRODUCTION

The prolonged reliance on fossil energies for strength product is using the persisting with upward thrust in carbon emigrations leading to climatic adaptations. In addition, the huge demand for fossil energies is depleting the factors of oil painting and gasoline, growing a need to probe the trade sources of strength manufacturing. Renewable power means are lesser feasible druthers which may

benon-depletable and might lessen the impact to the terrain. As the call shows, renewable power refers to energy that easily takes position and top out within the surroundings and doesn't exhaust, in assessment to the energy from fossil energies. One of the promising sources of renewable power it's long lasting and eco- quality in nature is sun photovoltaic power. The sun power with irradiance degrees of as important as $1\text{kW}/\text{m}^2$ is unstintingly to be had and photovoltaic power is a capability source for electrical energy period. Thus, solar cells have created large hobbyhorse in contemporary operations which encompass distributed energy product to offer exchange and easy energy. The primary features of photovoltaic electricity which makes it great from exceptional renewable electricity property are; It's abundant in nature and is loose and efficaciously to be had unlike the reactionary energies.

There is not any emigration of dangerous hothouse feasts and is an easy deliver of power manufacturing. They bear minimal keep and are reliable as they do no longer have any shifting factors and are free from climate. The photovoltaic power generation may be established in small- scale and distributed way, no longer just like the traditional power period systems which bear massive scale installations to serve. The photovoltaic power is available at some point of the cases whilst there may be top power call for still, the sun cells have a many essential walls which include low strength performance, massive area for installation, partial shading goods, cell declination, and numerous others. Power exertion circuits are defended within the device to manipulate the affair voltage and to modify the input voltage that's subordinated to oscillations in sun irradiation. Lots research works available in the literature on solar PV [Senthilkumar et al. \(2023\)](#), [Senthilkumar et al. \(2023\)](#), [Nathangashree et al. \(2016\)](#).

The Maximum Power Point Tracking (MPPT) set of rules is to maximize the charging contemporary in every type of dynamic conditions [Senthilkumar et al. \(2023\)](#), [Senthilkumar et al. \(2022\)](#). Around ninety-five voltages of the voltage score are maintained via battery and moderate voltage model also to present day maximization is taken into the account via MPPT algorithm, so the combined goods attain the MPP. It way, the general duty of maximizing the charging current or engaging in the MPP, is at the shoulder of MPPT algorithm. thus, on this assignment, an ultramodern- day set of rules is proposed for MPPT. This member, the general preface, and a number of the check of MPPT software are explained completely. Coming phase is used to explain about the literature work to enhance the energy factors and the performance of MPPT these days. The current strategies that dealt with the distinct strategies in MPPT is defined in ruin 3 and the chapter 4 described the proposed system of direct MPPT with its betterment. Chapter 5 describes all the results with appropriate discussion. Eventually, the article is concluded in chapter 6 independently.

2. LITERATURE SURVEY

Assessments on a marketable enterprise PV inverter is suggested to explore inter harmonious technology and lesser vital investigates the medium of inter harmonious emigration [Ahsan et al. \(2021\)](#), [Tey & Mekhilef \(2020\)](#), [Bighash et al. \(2021\)](#), [Hu et al. \(2021\)](#), [G et al. \(2023\)](#), [Aiello et al. \(2006\)](#), [Mohan et al. \(2017\)](#), [Munir & Li \(2019\)](#), [Sangwongwanich et al. \(2021\)](#), [Langella et al. \(2020\)](#), [Kjaer et al. \(2005\)](#). The studies exhibit that the anxieties of the Maximum Power Point Tracking (MPPT) algorithm is one of the means that induce inter harmonics in the grid present day, especially at low- electricity jogging conditions. Consequently, three mitigation results are mentioned to deal with this trouble, and simulations were

performed to corroborate the effectiveness of the answers. Simulation consequences recommend that the everyday- voltage MPPT fashion is the most suitable system to the mitigation of inter harmonics brought by using the MPPT operation, because it avoids the anxiety in the PV voltage. The generation mechanisms of inter harmonics in PV systems and the characteristics are offered [Munir & Li \(2019\)](#). Consequently, the Maximum Power Point Tracking (MPPT) regulator parameters at the side of the anxiety step size and the slice figure have an ineluctable effect on the inter harmonious characteristics. Further lesser, an approach to suggest the inter harmonics within the grid ultramodern- day is furnished. With this interpretation, inter harmonics may be anticipated harmonious with the designed regulator parameters in expressions of frequentness and confines. The results of experimental evaluation of inter harmonics produced thru PV inverters (PVIInv) for colorful multitudinous working conditions are proposed [Sangwongwanich et al. \(2021\)](#). First, natural inter harmonious generation due to MPPT manipulate is anatomized. latterly, period of ultramodern inter harmonics assessment is anatomized espousing the IEC 61000-4-7 sub- enterprise conception and their goods on the force voltage are estimated in expressions of brief- time period flicker indicator, Pst. Eventually, the paper investigates inter harmonious currents produced with the resource of PVIInv whilst harmonics and inter harmonics are superimposed to the essential deliver voltages. The actuality of inter harmonious emigrations from an MPPT driven grid- connected PV inverter, elect out their inflexibility and tolerance are suggested [Langella et al. \(2020\)](#), [Kjaer et al. \(2005\)](#). The presence of inter harmonics in the measured ultramodern- day- day from a PV installation is linked to direct and diffused sun irradiation in addition to a high ramping figure of the irradiation causing performances in every lively and reactive strength. The paper units forth a fixed of compliances and consequences, that's an accessory to the continuing exploration at the strength nice rudiments of solar energy. Three one among a type case exploration are estimated in element the operation of signal processing tools like STFT and FFT. An electricity extraordinary difficulty performing from grid- connected 3- phase photovoltaic inverters is proposed [Messo et al. \(2019\)](#). The range of grid- linked inverters has been developing step by step during the last decade because of growth in renewable power technology. These inverters were stated to degrade strength nice within the grid in areas wherein the quantum renewable electricity technology is big. still, the motives inside the lower reverse of the strength stylish issues are not still mainly said within the literature. The affair impedance of unattached and three- member PV inverters has been said to act a horrible resistance over a frequency variety which is grounded upon on the chosen manage scheme and control parameters. Negative resistance can motive impedance- primarily grounded relations which can also lead to insecurity, especially, indeed as the inverter is mounted to a susceptible grid which has huge inductance [Langella et al. \(2022\)](#), [Mohan & Senthilkumar \(2022\)](#). The predominant donation of this paper is the experimental consequences which actually display that the inverter has a large function at the advised strength great troubles. The inverter is verified to induce harmonious, inter harmonious or perhaps subharmonic currents counting on the reused power, element sizing, control parameters and the grid impedance.

3. EXISTING SYSTEM

As come preliminarily described, MPPT algorithms are important in PV programs due to the verity the MPP of a sun panel varies with the irradiation and temperature, so the operation of MPPT algorithms is demanded that permits you to

achieve the maximum strength from a solar array. Over the history a long time numerous strategies to find the MPP had been evolved and published. These strategies range in lots of factors which includes needed detectors, complexity, value, variety of effectiveness, confluence pace, correct shadowing indeed as irradiation and/ or temperature exchange, tackle demanded for the perpetration or fashion ability, amongst others. Among those ways, the P&O and the in Cond algorithms are the maximum common. These ways have the advantage of a smooth perpetration still in addition they've downsides, as can be established latterly. Other strategies grounded substantially on distinct generalities are fuzzy common-sense control, neural network, fractional open circuit voltage or quick circuit contemporary, contemporary reach, and plenitude of others. utmost of these styles yields a hard most and some, just like the fractional open circuit voltage or short circuit current, give an approached MPP, now not the precise bone. In ordinary situations the V- P wind has only one outside, so it isn't a problem. still, if the PV array is incompletely shadowed, there are further than one maxes in these angles. In order to relieve this problem, a many algorithms have been enforced. In this section, a number of the notorious MPPT ways are banded.

4. PROPOSED SYSTEM

In this work, MPPT set of guidelines with Honey Badger Optimization set of guidelines is furnished for PV systems. The terminal voltage, ultramodern and matching responsibility- cycle, at which the DC/ DC motor need to be switched to acquire maximum electricity affair, are determined. The artwork is performed in MATLAB/ Simulink terrain. Motor should be switched to gain maximum strength affair, are decided. The artwork is finished in MATLAB/ Simulink terrain. [Figure 1](#) shows the block diagram of the proposed system.

Figure 1

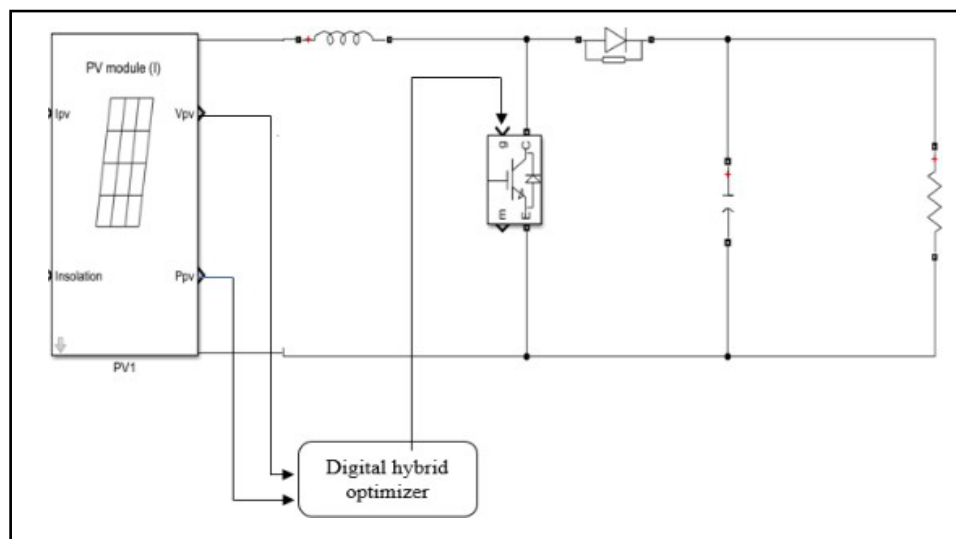


Figure 1 Proposed System - Block Diagram

Hybrid Honey Badger Optimization Algorithm

In this work, a Honey Badger optimization (HBO) algorithm with levy flight is presented which is based on Swarm based algorithm. The HBO is motivated from a honey badger's excellent foraging behaviour. This HBO method is presented mathematically to solve an optimization issue using a searching strategy. It carries

two strategies of honey badger with digging and honey searching strategy to provide an effective solution. This HBO provided an ample population diversity process to achieve a best solution in a larger landscape area. The Honey Badger Optimization is based on the foraging behaviour of Honey Badger.

The steps involved in HBO

- The candidate solutions population of HBO is expressed as follows.

$$\begin{matrix}
 X_{11} & X_{12} & \dots & X_{1P} \\
 X_{21} & X_{22} & \dots & X_{2P} \\
 \vdots & \vdots & & \vdots \\
 X_{n1} & X_{n2} & \dots & X_{nP}
 \end{matrix}$$

- $population(pop) = [x_1, x_2, \dots, x_l]$
- Honey badger l position, $x_1 = [x_1, x_2, \dots, x_l]$
- Step 1: Initialize the N number of the population and its positions using the following equation
- $x_l = l_{bl} + rm_1 \times (u_{bl} - l_{bl})$
- Where $x_l \rightarrow lth$ position of Honeybadger with respect to N, $rm_1 \rightarrow$

random number varies between zero to one, $u_{bl} \rightarrow$ Search domain upper bounds, $l_{bl} \rightarrow$ Search domain lower bounds

- Step 2: Defining intensity (I)
- The density of the badger is defined as the concentration strength of the prey based on its smell to search a prey. By using Inverse Square Law, the intensity of the badger is expressed as follows:

$$I = rm_2 \times \frac{S}{4\pi d_l^2}$$

Where $S = (x_l - x_{l+1})^2$, that indicated the concentration strength and $d_l = x_{prey} - x_l$, that indicated a distance between prey and lth honey badger

- Step 3: Density factor (α)
- It is a time-varying factor to improve the exploration and exploitation of optimization by smoothening and control.

$$\alpha = C \times \exp\left(-\frac{t}{t_{max}}\right)$$

Where,

$t_{max} \rightarrow$ Maximum number of iterations and $C \rightarrow$ Constant ≥ 1 (default = 2)

- Step 4: This step is followed to alter the search direction of the badger to escape from local minima.
- Step 5: The position of a badger is updated with respect to prey location and honey source

In the digging stage, a Cardioid shape motion is followed by a honey badger as follows:

$$X_{new} = X_{prey} + F \times \beta \times I \times X_{prey} + F \times rm_3 \times \alpha \times d_l \times |\cos(2\pi \cdot rm_4) \times [1 - \cos(2\pi \cdot rm_5)]|$$

(6)

Where, $X_{prey} \rightarrow$ Position of prey, $\beta \rightarrow$ Honey badger ability and F is used to change the searching direction of the badger and it can be stated as follows:

$$F = \begin{cases} 1 & \text{if } rm_6 \leq 0.5 \\ -1 & \text{else,} \end{cases}$$

- In the Honey phase, the badger follows the direction of the honeyguide bird to update the position as follows:

- $X_{new} = X_{prey} + F \cdot rm7 \cdot \alpha \cdot d_l$
- From equation (), it is clear that the honey badger is very close to its prey location (X_{prey}) based on d_l .

5. RESULTS AND DISCUSSIONS

The proposed MPPT model verified using MATLAB simulator. The panel and converter ratings are given in following Table 1. Different parameters of boost converter are tabulated in Table 2.

Table 1

Table 1 PV Cell Parameters	
Open circuit voltage (Voc)	60
Short circuit current (Isc)	6.5
Voltage at maximum point	4.5
Current at maximum point	4.5

Table 2

Table 2 Parameters of Boost Converter	
Parameter	Values
Ll	5.6mH
Cl	100mF
R	1K

Figure 2 shows the overall Simulink model of proposed MPPT model. It includes solar system, converter and MPPT controller.

Figure 2

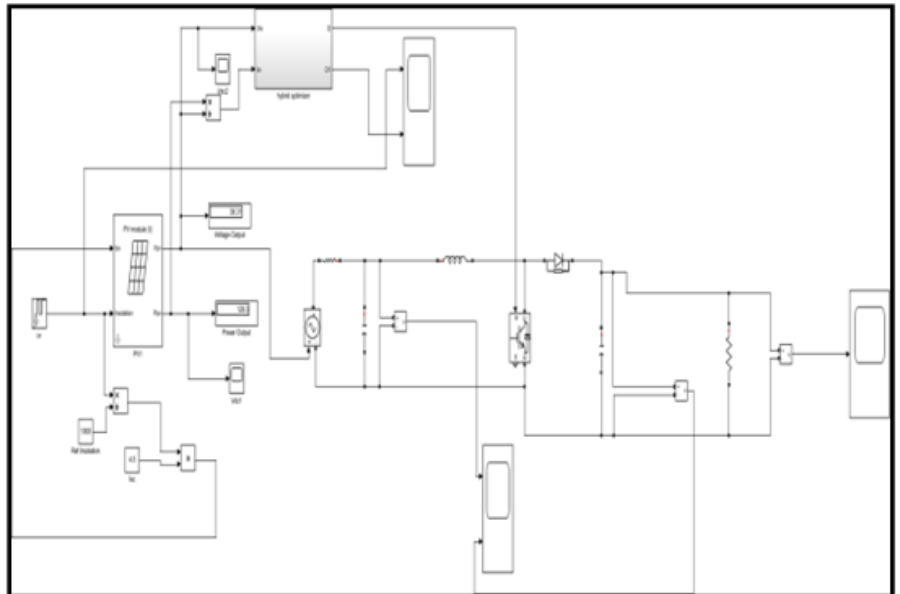


Figure 2 Over all Simulink Model

The following Figure 3 shows the panel parameters used for MPPT tracking the short circuit current set to 6.5 and open circuit voltage set to 60

Figure 3

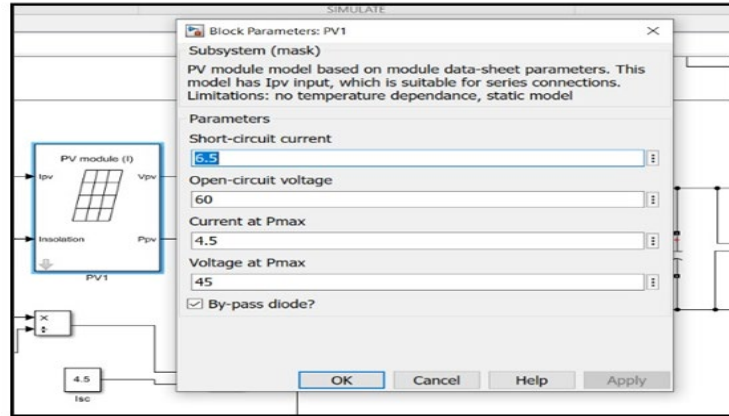


Figure 3 Panel Rating

5.1. RESULTS FOR IRRADIANCE PATTERN -1

Figure 4 shows the panel irradiance setting used for MPPT tracking. The above Figure 5 shows the proposed optimizer.

Figure 4

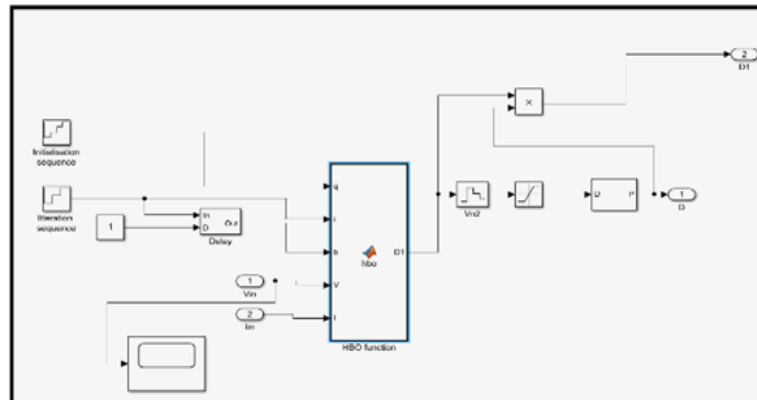


Figure 4 Irradiance Level Setting

Figure 5

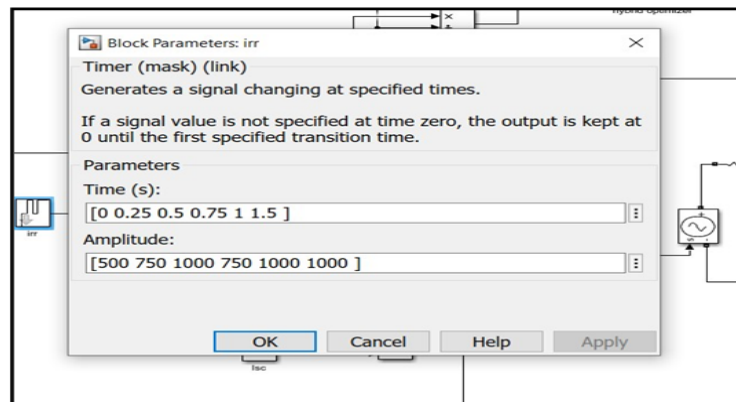


Figure 5 Hybrid Optimizer

The output of current and voltage from solar system fed to input for the controller. For evaluation, the irradiance level of solar system varied. The following [Figure 6](#) shows the DC-DC converter used for voltage boosting

Figure 6

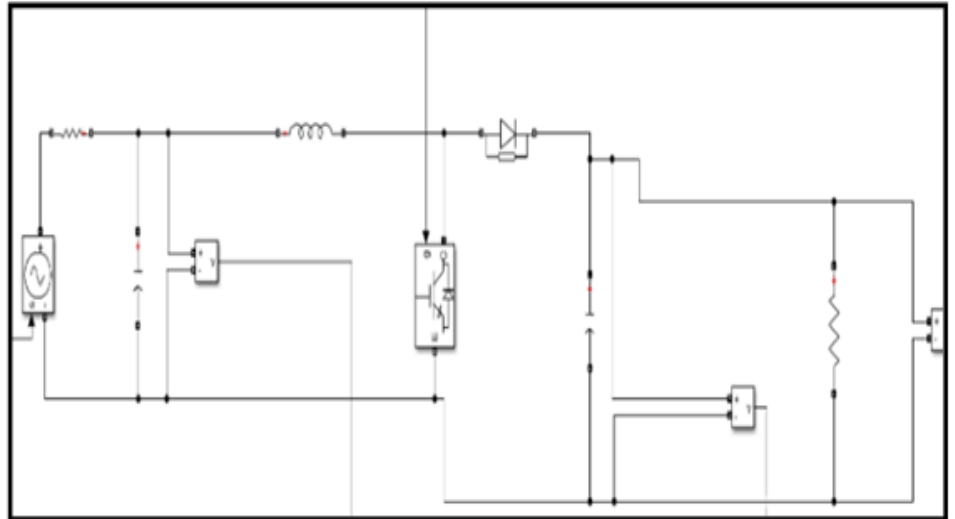


Figure 6 DC-DC Boost Converter

Figure 7

```

Editor: Block: fpo_HBOmppt/hybrid optimizer/HBO function
1 function D1 = hbo(q,i,b,v,I)
2 persistent P W D j k count f_new bounds current_power local_best_power fitness flower_best_duty
3
4
5 D1=-5;
6 if isempty(j)
7     j=1;
8 end
9 if isempty(k)
10    k=1;
11 end
12
13
14 if isempty(F)
15     F=zeros(1,3);
16 end
17
18 if isempty(D)
19     D=zeros(1,3);
20 end

```

Figure 7 Optimization for Tracking

The above [Figure 7](#) shows the HBO optimization modelling for MPPT tracking. The above [Figure 10](#) and [Figure 11](#) shows the performance of proposed MPPT model. The PWM of converter varied based on irradiance level and boosted voltage achieved with higher response time [Mohan et al. \(2015\)](#), [Chitrakala et al. \(2017\)](#), [Mohan et al. \(2012\)](#), [Mohan et al.\(2010\)](#), [Anitha & Mohan \(2015\)](#).

Figure 8



Figure 8 Irradiance Level

Figure 9

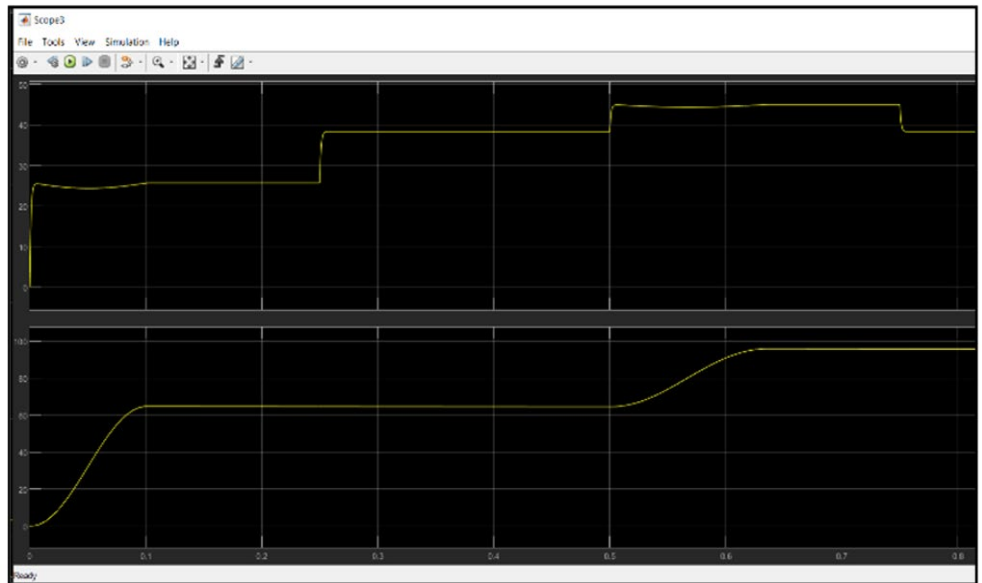


Figure 9 Irradiance with Tacking Output

5.2. RESULTS FOR IRRADIANCE PATTERN -2

Figure 9 shows the panel parameters used for MPPT tracking. The short circuit current set to 6.5 and open circuit voltage set to 60. Figure 10 shows the panel irradiance setting used for MPPT tracking. The irradiance level and irradiance with tracking output are shows in Figure 11 and Figure 12 respectively.

Figure 10

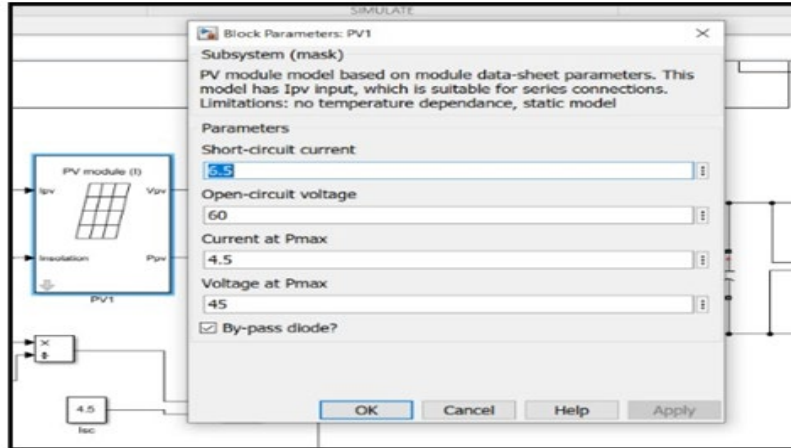


Figure 10 Panel Rating

Figure 11

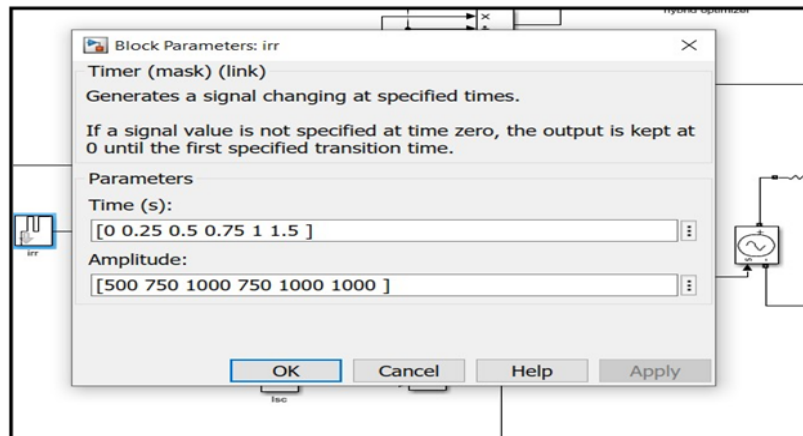


Figure 11 Irradiance Level Setting

Figure 12

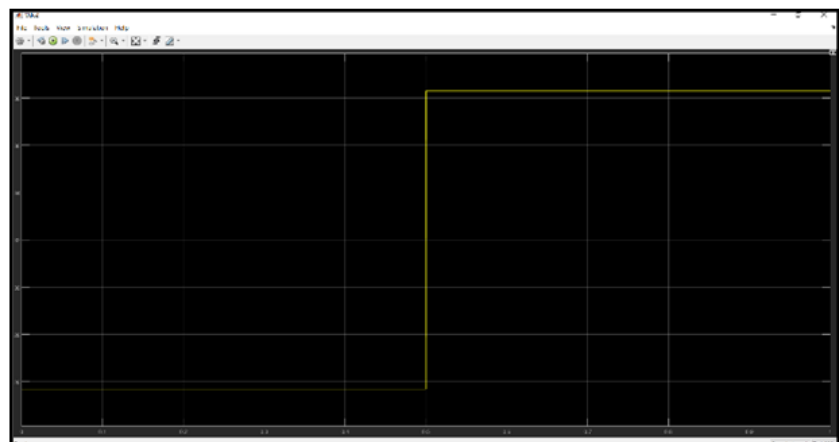


Figure 12 Irradiance Level

Figure 13

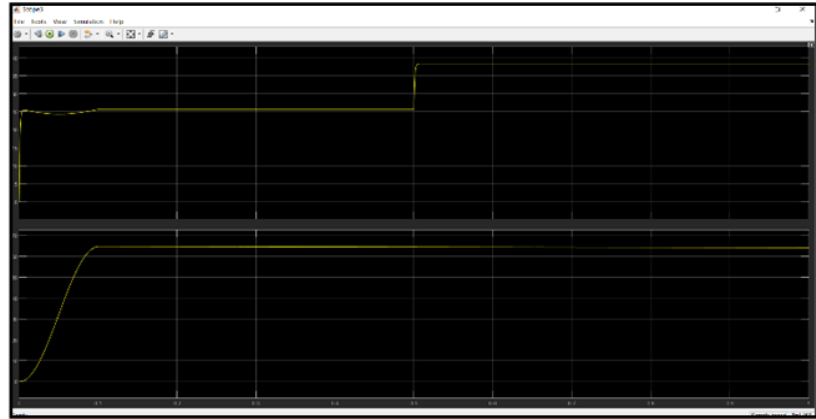


Figure 13 Irradiance with Tacking Output

The above figure shows the performance of proposed MPPT model. The PWM of converter varied based on irradiance level and boosted voltage achieved with higher response time. Table 3 shows the performance of the different MPPT algorithms. Figure 13 indicates the graphical model of the performance of the four different MPPT algorithms.

Table 3

Table 3 Performance Analysis

Methods	Average power (W)	Voltage at MPP(V)	Current at NOP(A)	Tracking time (s)
P&O	102.7	42.8	2.4	1.9
GWO	84.8	43.5	1.95	4.2
FPO	94	47	2	3.8
HBO	150	50	3	1.1

Figure 14

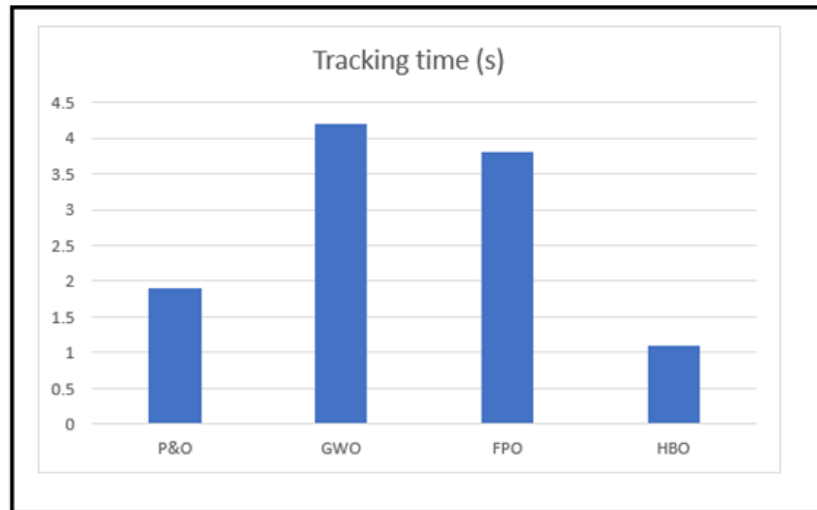


Figure 14 Performance Analysis

5.3. IMPLEMENTATION RESULTS

Prototype of the proposed system is shown in Figure 15. This model provides similar results when compared with simulation results.

Figure 15

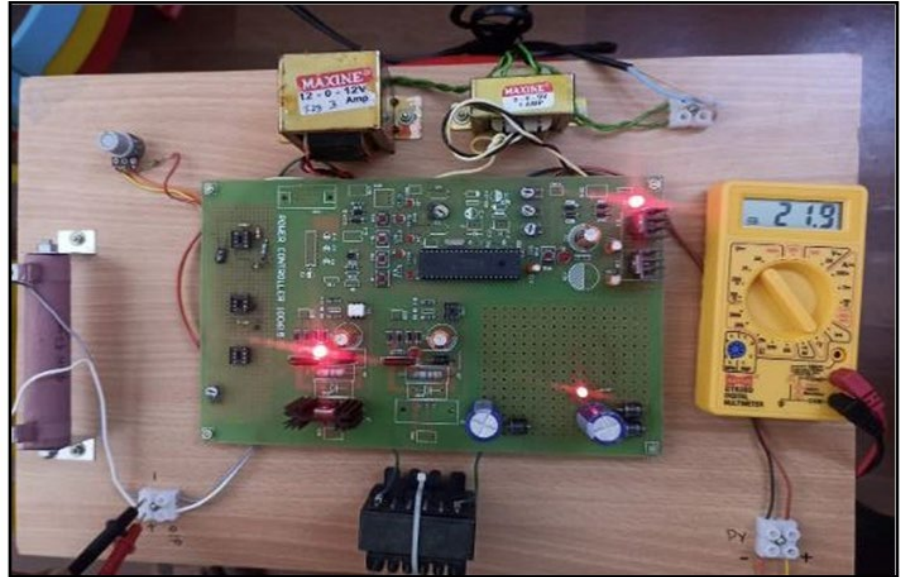


Figure 15 Proposed System - Prototype

6. CONCLUSION

In this artwork, the HBO grounded MPP shadowing is proposed for global top in solar tool. The HBO model is primarily grounded completely on rustling geste of Honey badger that has a digging and honey strategies. These phases are used to decide a maximum suitable result for GMPP monitoring. The overall performance of HBO approach is proven in expressions of electricity monitoring effectiveness and speed of confluence. The simulation end result of HBO system is as compared with a conventional system together with P&O, WOA and FSSO via MATLAB software operation. As a result, it's long hauls attained that the HBO interpretation supplied an advanced shadowing overall performance than all earlier strategies. Also, the HBO grounded fully MPPT fashion has graces of better shadowing overall performance, common electricity and hastily confluence than the former ways independently.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

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