Available online at www.qu.edu.iq/journalcm
JOURNAL OF AL-QADISIYAH FOR COMPUTER SCIENCE AND MATHEMATICS
ISSN:2521-3504(online) ISSN:2074-0204(print)

Optimal Parameters Estimation of Silicon Solar Cell Using Fuzzy Logic: Analytical Method

Maiada Nazar Mohammedali[a], Mohammed RASHEED[b, *], Suha SHIHAB[c], Taha RASHID[d], Saad Abed Hamad[e]

[a]*Applied Science Department, University of Technology, Baghdad, Iraq, e-mail: maiada.nazar@yahoo.com, 10856@uotechnology.edu.iq.*

[b]*Applied Science Department, University of Technology, Baghdad, Iraq, e-mail: rasheed.mohammed40@yahoo.com, 10606@uotechnology.edu.iq.*

[c]*Applied Science Department, University of Technology, Baghdad, Iraq, e-mail:alrawy1978@yahoo.com, 100031@uotechnology.edu.iq.*

[d]*Computerand Microelectronics System, Faculty of Engineering, University of Malaysia,Skudai 81310, Johor Bahru, Malaysia, e-mail: tsiham95@gmail.com, taha1988@graduate.utm.my.*

[e]*Saad Husein Abed Hamad- College of Computer Science & Information Technology, Al-Qadisiya University, Al-Diwaniyah, Iraq, e-mail: saad.hussain@qu.edu.iq, shsaadsh2014@gmail.com*

ARTICLE INFO

Article history:
Received: 25 /11/2020
Rrevised form: 25 /12/2020
Accepted : 13 /01/2021
Available online: 22 /01/2021

Keywords:

Efficiency of solar cell, maximum voltage, maximum current density, fuzzy logic theory.

ABSTRACT

In This research, the fuzzy logic (FC) method was used to calculate the main parameters of photovoltaic cell. Some of the basic silicon solar cell parameters were measured in the laboratory. A fuzzy logic method is used to demonstrate and compared the value of the solar cell's parameters corresponding to I-V curve of this cell. The results showed that the fuzzy logic method is very suitable for comparing the optimal values of the photovoltaic cell parameters.

MSC. 41A25; 41A35; 41A36

DOI : https://doi.org/10.29304/jqcm.2021.13.1.741

*Corresponding author: Mohammed RASHEED.

Email addresses: rasheed.mohammed40@yahoo.com, 10606@uotechnology.edu.iq

Communicated by: Alaa Hussein Hamadi

1. Introduction

Diode is a broad science, the work of a large industrial revolution and its various types, the science of diode and transistors every day when we learn new things. Photovoltaic cell, or the so-called Solar Cell, is a pn-junction diode with no voltage directly through the junction, and it converts the energy of the photon falling on it's surface to electrical energy and then transmits to the load (Load) located across the ends of the circle. Solar cells were used in the beginning of the fifties to the present time as power supplies for satellites, spacecraft and some pocket calculators. Several researchers used numerical methods for solving nonlinear equations of many applications [1-10]. These methods such as Chebyshev wavelets, Taylor series, orthonormal Bernstein polynomial, spline function, spline multiscaling, variational calculus, integral equations, linear systems, and operational matrix can be used for solving the basic equation of solar cells [11-23]. Several applications have been used with solar cells even in the sky with the satellite orbits or celestial mechanics [24-31].

A fuzzy set theory is applied to calculate the PV parameters by means of its electrical circuit. All these parameters were measured practically in indoor calculations.

2. Parameters of Photovoltaic

Depending on the electric circuit for photovoltaic cell and practically the load resistance has been used to obtain the output power resulting from I-V characteristics. Investigating current-voltage curve, the two important parameters of a photovoltaic cell such as Fill Factor FF and efficiency η can be calculated using the following equations [32-63].

$$FF = P_m/V_{oc}I_{sc} = V_m I_m/V_{oc}I_{sc} \tag{1}$$

$$\eta = V_{oc} \times I_{sc} \times FF/P_{in} \times 100\% \tag{2}$$

where: V_{oc}, I_{sc}, I_m and P_{in}: is open circuit voltage (V), short circuit current (A), maximum current (A) and intensity of the arriving photons (mW/cm^2) respectivelly, V_m is maximum voltage (V), FF is fill factor.

3. Fuzzy Set Technique [56-60]

The beginning of interest in this science and the work of its study began in the nineteenth century, when George Cantor and Richard Dykind started it. Following the discovery of many contradictions in the theory of the basic groups, many axiom systems were proposed to overcome these contradictions, and from this, the Zermlo-Franklin system with the axiom of choice was the best of all.

Set theory is a branch of mathematical logic, concerned with the study of groups, which are a collection of abstract mathematical beings, and the processes applied to them, and they constitute one of the most important pillars of modern mathematics.

There are various types of compositions of fuzzy relations as follows [61-63]

1. Composition of fuzzy relations R and S

$$SR = SoR = \{((x, y, \mu_{SR}(x, z))\} \tag{3}$$

where $\mu_{SR}(x, z) = \max - \min[\mu_R(x, y), \mu_S(y, z)]$ (4)

2. Composition of crisp sets A and B. It can represent a relation R between the sets A and B

$$R = \{(x, y)|x \in A, y \in B\}, R \subseteq A \times B \tag{5}$$

3. Composition of fuzzy sets A and B. It is a relation R between fuzzy sets A and B

$$R = \{[(x, y)\ , \mu_R(x, y)|\mu_R(x, y)\}, \text{where: } \mu_R(x, y) = \min[\mu_A(x), \mu_B(y))] \tag{6}$$

$$\text{or } \mu_R(x, y) = \mu_A(x) \bullet \mu_B(y)\} \tag{7}$$

4. Composition of crisp relations R and S

$$S \times R = \{(x,z) | (x,y) \epsilon R, (y,z) \epsilon S\} \text{ where } R \subseteq A \times B, S \subseteq B \times C, \text{ and } SoR \subseteq A \times C \quad (8)$$

Fuzzy expression idea makes a formal description of the relationship between two fuzzy sets. Therefore, fuzzy sets are a good tool for representing values of the parameters required.

4. Results and Discussion

Table 1 show the parameters of photovoltaic cell achieved practically by O. A. Sultan et al., then we took these results of fuzzy set applications.

(T, J_{sc}, V_{oc}) are the input parameters and ($R_m, J_m, V_m, FF, \eta_m, \tau, R_s, R_{sh}$) are the output parameters, where: J_{sc} is the open-circuit current density, J_m is maximum current density, R_s is series resistance, R_{sh} is shunt resistance, and τ is minority carrier lifetime. The class of membership function, which characterized by a function $\mu_{\tilde{A}}(t) = 1/(\sqrt{t})^{1/9}$ for photovoltaic solar cell parameters as shown in Figs. 1-11

Table 1 - The effect of temperature on the solar sell parameters.

T (°C)	J_{sc} (mA/cm²)	V_{oc} (V)	R_m (Ω)	J_m (mA/cm²)	V_m (V)	FF	R_{sh} (kΩ)	R_s (kΩ)	τ (μs)	η_m (%)
1	3.52	2.1	5	3.38	1.2	0.55	5.9	-	0.26	4.5
2	4.86	2.2	5	3.52	1.35	0.44	6.9	15.6	0.18	10
3	4..6	1.97	5	4	1.1	0.48	6.4	18.5	0.11	3.9
4	4.8	1.8	5	3.4	1.2	0.47	5.9	23.1	0.12	1.8
5	4.4	1.75	5	3.75	0.82	0.39	4.45	26	1	1.2
6	4.5	1.76	5	3.9	0.85	0.41	4.8	29.5	1	1.25

Fuzzy logic aims at the importance of criteria and the interactions between them and has excellent potential for applications in various scientific fields.

Let U be the set of all the temperatures that can exist in the universe and let T be a group representing the classified (low) temperatures. Let us take from the group U the element u = 5 °C, this is a cold temperature so it is therefore belongs to the group T completely. If someone took the temperature u = 70 °C, so this temperature is very hot, so the element u does not belong at all to the T group, and this is from the point of view of classical or (traditional) logic. While this is very important notes that is (in fuzzy logic, we can say that u belongs to T in a certain proportion).

In order to design a fuzzy logic system for a solar cell, we will define the membership functions (dependent affiliation) of the input (parameters) to determine the degree of truth in each point. Figs. 1-11 show the degree of membership (membership function) for each element to each parameter of the solar cell.

Figure 1 shows the degree of membership (degree of affiliation) of each element within the recorded low temperature group of the solar cell

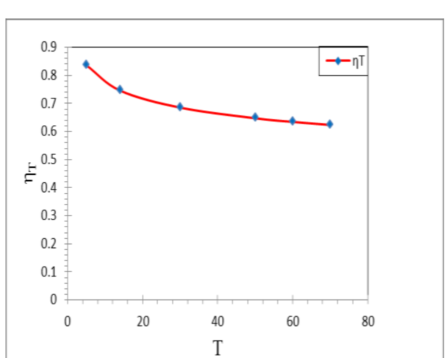

Fig. 1 – Membership function of temperature T.

Figure 2 shows the degree of membership (degree of affiliation) of each element within the recorded short circuit current density J_{sc} group of the solar cell.

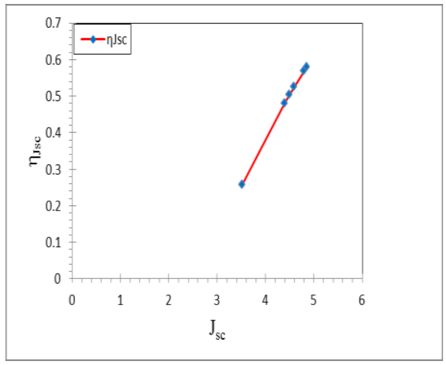

Fig. 2 – Membership function of short circuit current density J_{sc}.

Figure 3 shows the degree of membership (degree of affiliation) of each element within the recorded short circuit voltage V_{sc} group of the solar cell.

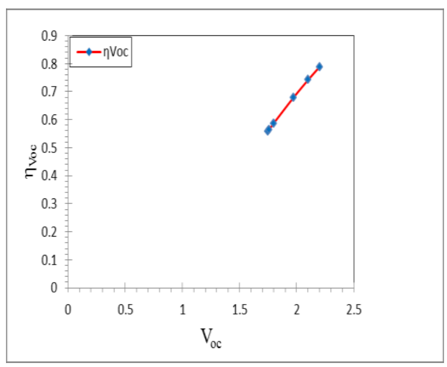

Fig. 3 – Membership function of short circuit voltage V_{sc}.

Figure 4 shows the degree of membership (degree of affiliation) of each element within the recorded maximum resistance R_m of the solar cell.

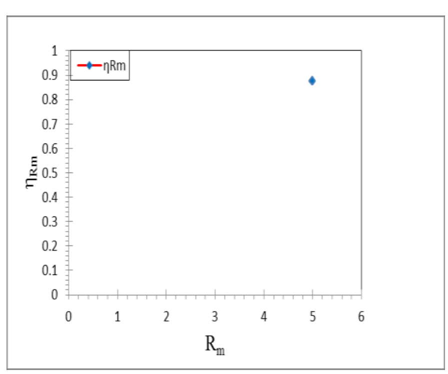

Fig. 4 – Membership function of short circuit voltage V_{sc}.

Figure 5 shows the degree of membership (degree of affiliation) of each element within the recorded maximum current density J_m group of the solar cell.

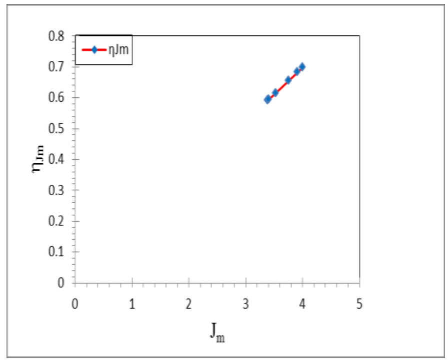

Fig. 5 – Membership function of maximum current density J_m.

Figure 6 shows the degree of membership (degree of affiliation) of each element within the recorded maximum voltage V_m group of the solar cell.

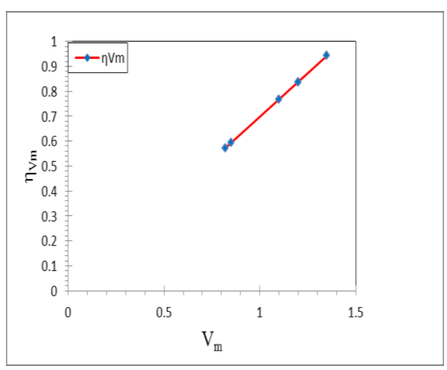

Fig. 6 – Membership function of maximum voltage V_m.

Figure 7 shows the degree of membership (degree of affiliation) of each element within the recorded fill factor FF group of the solar cell.

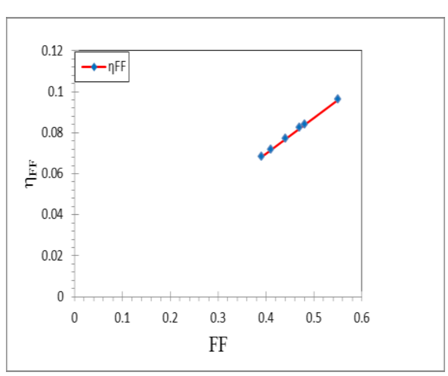

Fig. 7 – Membership function of fill factor FF.

Figure 8 shows the degree of membership (degree of affiliation) of each element within the recorded maximum efficiency η_m group of the solar cell.

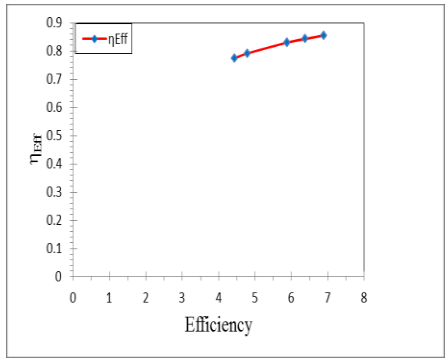

Fig. 8 – Membership function of maximum efficiency η_m.

Figure 9 shows the degree of membership (degree of affiliation) of each element within the recorded life time τ group of the solar cell.

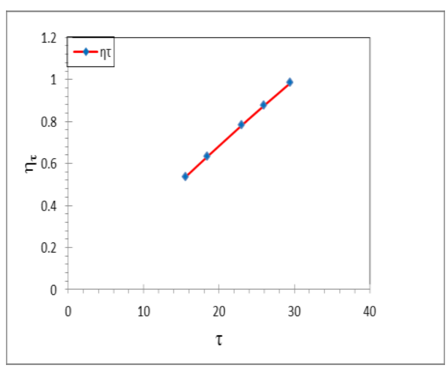

Fig. 9 – Membership function of life time τ.

Figure 10 shows the degree of membership (degree of affiliation) of each element within the recorded series resistance R_s group of the solar cell.

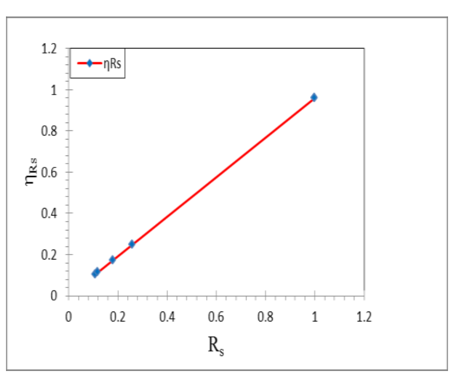

Fig. 10 – Membership function of series resistance R_s.

Figure 11 shows the degree of membership (degree of affiliation) of each element within the recorded parallel shunt R_{sh} group of the solar cell.

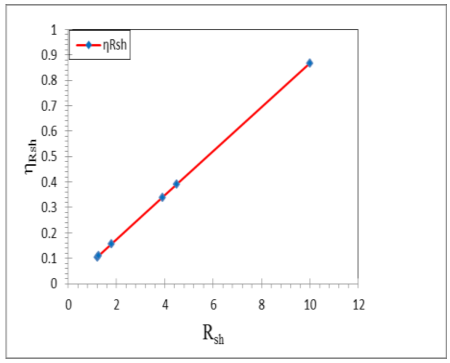

Fig. 11 – Membership function of parallel shunt R_{sh}.

The result of operations for the relation between the temperature T fuzzy set with FF (fill factor) fuzzy set by applying Eqs. 6 and 7, one can see the following Tables 2-11.

Table 2 shows the relationship between the temperature of the fuzzy group and one of the parameters of the solar cell is the result reached through the composition of the fuzzy group of temperatures with one of the fuzzy parameters (fill factor) from the application of one of the inference rules (fuzzy relation).

Table 2 - The relation between temperature fuzzy set with fill factor fuzzy set.

T	J_{Sc}					
	3.52	**4.4**	**4.5**	**4.6**	**4.86**	**4.8**
5	0.216087	0.402738	0.421554	0.436188	0.485861	0.475505
14	0.122728	0.359201	0.375983	0.392393	0.433339	0424102
30	0.177079	0.330036	0.345455	0.360531	0.398153	0.389667
50	0.167306	0.377822	0.326389	0.340634	0.376180	0.368162
60	0.163953	0.305572	0.319848	0.333807	0.360783	0.368641
70	0.1611689	0.300383	0.314417	0.328139	0.362381	0.362381

Table 3 shows the relationship between the temperature of the fuzzy group and one of the parameters of the solar cell is the result reached through the composition of the fuzzy group of temperatures with one of the fuzzy parameters (open circuit voltage) from the application of one of the inference rules (fuzzy relation).

Table 3 - The relation between temperature fuzzy set with fill factor fuzzy set.

T	V_{oc}					
	1.75	**1.76**	**1.8**	**1.97**	**2.1**	**2.2**
5	0.467966	0.472732	0.491548	0.566976	0.620414	0.659299
14	0.417378	0.421629	0.438411	0.505686	0.553346	0.588028
30	0.417378	0.421629	0.438410	0.505686	0.553346	0.582028
50	0.362324	0.366015	0.380583	0.438985	0.480356	0.510465
60	0.355063	0.358679	0.372256	0.430187	0.470731	0.500235
70	0.349033	0.352588	0.366622	0.422881	0.462737	0.491740

Table 4 shows the relationship between the temperature of the fuzzy group and one of the parameters of the solar cell is the result reached through the composition of the fuzzy group of temperatures with one of the fuzzy parameters (maximum resistance) from the application of one of the inference rules (fuzzy relation).

Table 4 - The relation between temperature fuzzy set with fill factor fuzzy set.

T	R_m					
	5	**5**	**5**	**5**	**5**	**5**
5	0.648329	0.648329	0.648329	0.648329	0.648329	0.648329
14	0.578243	0.578243	0.578243	0.578243	0.578243	0.578243
30	0.531292	0.531292	0.531292	0.531292	0.531292	0.531292
50	0.501971	0.501971	0.501971	0.501971	0.501971	0.501971
60	0.491911	0.491911	0.491911	0.491911	0.491911	0.491911
70	0.483557	0.483557	0.483557	0.483557	0.483557	0.483557

Table 5 shows the relationship between the temperature of the fuzzy group and one of the parameters of the solar cell is the result reached through the composition of the fuzzy group of temperatures with one of the fuzzy parameters (current density) from the application of one of the inference rules (fuzzy relation).

Table 5 - The relation between temperature fuzzy set with fill factor fuzzy set.

T	J_m					
	3.38	**3.4**	**3.52**	**3.75**	**3.9**	**4**
5	0.93053	0.495979	0.513374	0.546908	0.568817	0.583368
14	٠,٤٣٩٧٥٣	0.442364	0.457877	0.847786	0.507327	0.520305
30	٠,٤٠٤٦٤٧	0.406445	0.420699	0.448179	0.466134	0.478058
50	٠,٣٨١٧٤٨	0.383949	0.397482	0.423445	0.440409	0.451675
60	0.374098	0.376318	0.389516	0.414959	0.431583	0.442623
70	٠,٣٦٧٧٤٥	0.369928	0.382901	0.407912	0.424254	0.435106

Table 6 shows the relationship between the temperature of the fuzzy group and one of the parameters of the solar cell is the result reached through the composition of the fuzzy group of temperatures with one of the fuzzy parameters (maximum voltage) from the application of one of the inference rules (fuzzy relation).

Table 6 - The relation between temperature fuzzy set with fill factor fuzzy set.

T	V_m					
	0.82	**0.85**	**1.1**	**1.2**	**1.2**	**1.35**
5	0.478669	0.496230	0.642156	0.700527	0.700527	0.788082
14	0.426925	0.442587	0.505612	0.624799	0.624799	0.702889
30	0.392259	0.406651	0.52623	0.574067	0.574067	0.645817
50	0.370612	0.384209	0.497192	0.542386	0.542386	0.610176
60	0.363184	0.376509	0.487228	0.531516	0.531516	0.597947
70	0.357017	0.370115	0.478954	0.522489	0.522489	0.587793

Table 7 shows the relationship between the temperature of the fuzzy group and one of the parameters of the solar cell is the result reached through the composition of the fuzzy group of temperatures with one of the fuzzy parameters (fill factor) from the application of one of the inference rules (fuzzy relation).

Table 7 - The relation between temperature fuzzy set with fill factor fuzzy set.

T	*FF*					
	0.39	**0.41**	**0.44**	**0.47**	**0.48**	**0.55**
5	0.056921	0.059840	0.064219	0.068597	0.070057	0.080272
14	0.050768	0.053371	0.057277	0.061182	0.062483	0.071595
30	0.046646	0.049038	0.052626	0.056214	0.057410	0.065782
50	0.044071	0.046331	0.049722	0.053112	0.054242	0.062152
60	0.043188	0.045403	0.048725	0.052047	0.053155	0.060906
70	0.042455	0.044632	0.047898	0.051163	0.052252	0.059875

Table 8 shows the relationship between the temperature of the fuzzy group and one of the parameters of the solar cell is the result reached through the composition of the fuzzy group of temperatures with one of the fuzzy parameters (efficiency) from the application of one of the inference rules (fuzzy relation).

Table 8 - The relation between temperature fuzzy set with fill factor fuzzy set.

T	η					
	4.45	**4.8**	**5.9**	**6.4**	**6.9**	**5.9**
5	0.648329	0.662032	0.694512	0.705586	0.715054	0.694512
14	0.578243	0.590465	0.619434	0.629311	0.637755	0.619434
30	0.531292	0.542521	0.569139	0.578213	0.585972	0.569139
50	0.501971	0.512581	0.537729	0.546303	0.553633	0.537729
60	0.491911	0.502308	0.526952	0.535354	0.542598	0.526952
70	0.483557	0.493778	0.518004	0.526263	0.533325	0.518004

Table 9 shows the relationship between the temperature of the fuzzy group and one of the parameters of the solar cell is the result reached through the composition of the fuzzy group of temperatures with one of the fuzzy parameters (life time) from the application of one of the inference rules (fuzzy relation).

Table 9 - The relation between temperature fuzzy set with fill factor fuzzy set.

T	τ					
	-	**15.6**	**18.5**	**23.1**	**26**	**29.5**
5		0.449735	0.53068	0.656205	0.733140	0.823539
14		0.401118	0.473316	0.585268	0.653887	0.734513
30		0.3685449	0.434885	0.537747	0.600794	0.674874
50		0.348209	0.410884	0.508069	0.567637	0.637628
60		0.341231	0.402650	0.499601	0.556261	0.624850
70		0.335436	0.395812	0.489432	0.546814	0.614238

Table 10 shows the relationship between the temperature of the fuzzy group and one of the parameters of the solar cell is the result reached through the composition of the fuzzy group of temperatures with one of the fuzzy parameters (series resistance) from the application of one of the inference rules (fuzzy relation).

Table 10 - The relation between temperature fuzzy set with fill factor fuzzy set.

T	R_s					
	0.11	**0.12**	**0.18**	**0.26**	**1**	**1**
5	0.088308	0.096336	0.144504	0.208728	0.802716	0.802716
14	0.078762	0.085922	0.128883	0.186164	0.715941	0.715941
30	0.072367	0.078945	0.118448	0.171048	0.657810	0.657810
50	0.068373	0.074589	0.111883	0.161609	0.621506	0.621506
60	0.067003	0.073094	0.109641	0.158370	0.609051	0.609051
70	0.065865	0.071852	0.010779	0.155680	0.598708	0.598708

Table 11 shows the relationship between the temperature of the fuzzy group and one of the parameters of the solar cell is the result reached through the composition of the fuzzy group of temperatures with one of the fuzzy parameters (parallel resistance) from the application of one of the inference rules (fuzzy relation).

Table 11 - The relation between temperature fuzzy set with fill factor fuzzy set.

T	R_{sh}					
	1.2	**1.25**	**1.8**	**3.9**	**4.5**	**10**
5	0.087555	0.091235	0.131375	0.284409	0.327894	0.726032
14	0.078090	0.081372	0.117173	0.253664	0.292448	0.647547
30	0.071750	0.074765	0.107659	0.233067	0.968702	0.594969
50	0.067790	0.070639	0.101718	0.220205	0.253873	0.562133
60	0.066432	0.069223	0.099679	0.215791	0.248785	0.550868
70	0.065303	0.068048	0.097986	0.212127	0.244560	0.541513

The fuzzy logic is designed in order to measure the best efficiency of a low fuzzy logic temperature. Where the model based on the possibility of showing the efficiency ratio within a range of recorded points 50, 60 and 70 which is considered (when using classical logic (traditional) not belonging to the low temperature level) and activating it in a way that depends on the fuzzy basic parameters of the solar cell, which is (the fuzzy current density group, fuzzy maximum resistance group, fuzzy open circuit voltage, fuzzy maximum current density, Fuzzy maximum voltage, fuzzy fill factor, fuzzy maximum efficiency, fuzzy relaxation time, fuzzy series resistance and fuzzy shunt resistance).

By comparing the results of Table 1 with the results of Tables 2, 3,4 ,5 ,6 ,7 ,8 ,9 ,10 and 11, it was confirmed that the values and the recorded results of the solar cell's parameters' in the conventional case were correct based on (each conventional group is a group fuzzy).

5. Conclusion

Solar cells offer a potentially attractive means for direct conversion of sunlight into electricity with high reliability and low maintenance as compared with solar thermal systems. The disadvantages are high cost and difficulty of storing large amount of electricity for later use as compared with the relative case of storing heat for later use. The cost of generating electric power with solar calls can be reduced by using concentrator to focus sunlight on to the cell. Fuzzy logic method is very convenient for comparing the optimal values of the PV parameters.

REFERENCES

[1] M. A. Sarhan, "Effect of Silicon Solar Cell Physical Factors on Maximum Conversion Efficiency Theoretically and Experimentally", Insight-Electronic, vol. 1 (1), (2019), pp. 24-30.

[2] M. A. Sarhan, S. Shihab, B. E. Kashem and M. Rasheed, "New Exact Operational Shifted Pell Matrices and Their Application in Astrophysics", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.

[3] F. S. Tahir, and M. S. Rasheed, "Decline in the Performance of Silicon Solar Cell Parameters with the Ambient Temperature in Baghdad", Journal of the College of Basic Education, vol. 18 (75), (2012), pp. 95-111.

[4] F. S. Tahir, M. S. Rasheed, and I. A. Hameed, "Analysis the Performance of Silicon Solar Cell Parameters with the Ambient Temperature using Fuzzy Logic", Journal of the College of Basic Education, vol. 18 (75), (2012), pp. 173-183.

[5] R. Jalal, S. Shihab, M. A. Sarhan, and M. Rasheed. "Spectral Numerical Algorithm for Solving Optimal Control Using Boubaker-Turki Operational Matrices", In Journal of Physics: Conference Series, vol. 1660, no. 1, p. 012090. IOP Publishing, (2020).

[6] M. RASHEED, "Linear Programming for Solving Solar Cell Parameters", Insight-Electronic, vol. 1 (1), (2019), pp. 10-16.

[7] M. RASHEED, and M. A. Sarhan, "Solve and Implement the main Equations of Photovoltaic Cell Parameters Using Visual Studio Program", Insight-Mathematics, vol. 1 (1), (2019), pp. 17-25.

[8] M. Rasheed, and R. Barillé, "Room temperature deposition of ZnO and Al: ZnO ultrathin films on glass and PET substrates by DC sputtering technique", Optical and Quantum Electronics, vol. 49 (5), (2017), pp. 1-14.

[9] M. RASHEED, and S. SHIHAB, "Analytical Modeling of Solar Cells", Insight Electronics, vol. 1 (2), (2019), pp. 1-9.

[10] M. RASHEED, and S. SHIHAB, "Modifications to Accelerate the Iterative Algorithm for the Single Diode Model of PV Model", Iraqi Journal of Physics (IJP), vol. 18 (47), (2020), pp. 33-43.

[11] M. Rasheed, and S. Shihab, "Numerical Techniques for Solving Parameters of Solar Cell", Applied Physics, vol. 3 (1), (2020), pp. 16-27.

[12] M. RASHEED, and S. SHIHAB, "Parameters Estimation for Mathematical Model of Solar Cell", Electronics Science Technology and Application, vol. 6, (1), (2019), pp. 20-28.

[13] M. Rasheed, O. Alabdali and S. Shihab, "A New Technique for Solar Cell Parameters Estimation of The Single-Diode Model", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.

[14] M. Rasheed, O. Y. Mohammed, S. Shihab, and Aqeel Al-Adili, "A comparative Analysis of PV Cell Mathematical Model", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.

[15] M. Rasheed, O. Y. Mohammed, S. Shihab, and Aqeel Al-Adili, "Explicit Numerical Model of Solar Cells to Determine Current and Voltage", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.

[16] M. Rasheed, O. Y. Mohammed, S. Shihab, and Aqeel Al-Adili, "Parameters Estimation of Photovoltaic Model Using Nonlinear Algorithms", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.

[17] M. S. Rasheed, and S. Shihab, "Analysis of Mathematical Modeling of PV Cell with Numerical Algorithm". Advanced Energy Conversion Materials, vol. 1 (2), (2020), pp. 70-79. Available from: http://ojs.wiserpub.com/index.php/AECM/article/view/328.

[18] M. RASHEED, S. SHIHAB, T. RASHID and T. D. Ounis, "Determination of PV Model Parameters Using Bisection and Secant Methods", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13, (1), (2021), pp. 43-54.

[19] M. S. Rasheed and S. Shihab, "Modelling and Parameter Extraction of PV Cell Using Single-Diode Model". Advanced Energy Conversion Materials, 1 (2), (2020), pp. 96-104. Available from: http://ojs.wiserpub.com/index.php/AECM/article/view/550.

[20] M. S. Rasheed, "Acceleration of Predictor Corrector Halley Method in Astrophysics Application", International Journal of Emerging Technologies in Computational and Applied Sciences, vol. 1 (2), (2012), pp. 91-94.

[21] S. Shihab, M. Rasheed, O. Alabdali and A. A. Abdulrahman, "A Novel Predictor-Corrector Hally Technique for Determining The Parameters for Nonlinear Solar Cell Equation", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.

[22] S. SHIHAB, and M. RASHEED, "Modeling and Simulation of Solar Cell Mathematical Model Parameters Determination Based on Different Methods", Insight Mathematics, vol. 1 (1), (2019), pp. 1-16.

[23] A. A. Abdulrahman, M. RASHEED and S. SHIHAB, "The Analytic of Image Processing Smoothing Spaces Using Wavelet", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.

[24] A. AUKŠTUOLIS, M. Girtan, G. A. Mousdis, R. Mallet, M. Socol, and M. Rasheed, "A. Stanculescu, Measurement of charge carrier mobility in perovskite nanowire films by photo-CELIV method", Proceedings of the Romanian Academy Series a-Mathematics Physics Technical Sciences Information Science, vol. 18 (1), (2017), pp. 34-41.

[25] D. Bouras, A. Mecif, R. Barillé, A. Harabi, M. Rasheed, A. Mahdjoub, and M. Zaabat, "Cu: ZnO deposited on porous ceramic substrates by a simple thermal method for photocatalytic application", Ceramics International, vol. 44 (17), (2018), pp. 21546-21555.

[26] E. Kadri, K. Dhahri, A. Zaafouri, M. Krichen, M. Rasheed, K. Khirouni, and R. Barillé, "Ac conductivity and dielectric behavior of a−Si:H/c−Si1−yGey/p−Si thin films synthesized by molecular beam epitaxial method", Journal of Alloys and Compounds, vol. 705, (2017), pp. 708-713.

[27] E. Kadri, M. Krichen, R. Mohammed, A. Zouari, and K. Khirouni, "Electrical transport mechanisms in amorphous silicon/crystalline silicon germanium heterojunction solar cell: impact of passivation layer in conversion efficiency", Optical and Quantum Electronics, vol. 48 (12), (2016), pp. 1-15.

[28] S. H. Aziz, S. SHIHAB, M. RASHEED, "On Some Properties of Pell Polynomials", Al-Qadisiyah Journal of Pure Science, vol. 26, (1), (2020), pp. 39-54.

[29] M. A. Sarhan, S. SHIHAB, M. RASHEED, "Some Results on a Two Variables Pell Polynomials", Al-Qadisiyah Journal of Pure Science, vol. 26, (1), (2020), pp. 55-70.

[30] E. Kadri, O. Messaoudi, M. Krichen, K. Dhahri, M. Rasheed, E. Dhahri, A. Zouari, K. Khirouni, and R. Barillé, "Optical and electrical properties of SiGe/Si solar cell heterostructures: Ellipsometric study", Journal of Alloys and Compounds, vol. 721, (2017), pp. 779-783.

[31] F. Dkhilalli, S. M. Borchani, M. Rasheed, R. Barille, K. Guidara, and M. Megdiche, "Structural, dielectric, and optical properties of the zinc tungstate ZnWO4 compound", Journal of Materials Science: Materials in Electronics, vol. 29 (8), (2018), pp. 6297-6307.

[32] F. Dkhilalli, S. M. Borchani, M. Rasheed, R. Barille, S. Shihab, K. Guidara, and M. Megdiche, "Characterizations and morphology of sodium tungstate particles", Royal Society open science, vol. 5 (8), (2018), pp. 1-12.

[33] F. Dkhilalli, S. Megdiche, K. Guidara, M. Rasheed, R. Barillé, and M. Megdiche, "AC conductivity evolution in bulk and grain boundary response of sodium tungstate Na_2WO_4", Ionics, vol. 24 (1), (2018), pp. 169-180.

[34] K. Guergouria A. Boumezoued, R. Barille, D. Rechemc, M. Rasheed, and M. Zaabata, "ZnO nanopowders doped with bismuth oxide, from synthesis to electrical application", Journal of Alloys and Compounds, vol. 791, (2019), pp. 550-558.

[35] M. Enneffati, B. Louati, K. Guidara, M. Rasheed, and R. Barillé, "Crystal structure characterization and AC electrical conduction behavior of sodium cadmium orthophosphate", Journal of Materials Science: Materials in Electronics, vol. 29 (1), (2018), pp. 171-179.

[36] M. Enneffati, M. Rasheed, B. Louati, K. Guidara, and R. Barillé, "Morphology, UV–visible and ellipsometric studies of sodium lithium orthovanadate", Optical and Quantum Electronics, vol. 51 (9), (2019), vol. 299.

[37] M. Enneffati, M. Rasheed, B. Louatia, K. Guidaraa, S. Shihab, and R. Barillé, "Investigation of structural, morphology, optical properties and electrical transport conduction of Li0.25Na0.75CdVO4 compound", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.

[38] M. M. Abbas and M. Rasheed, "Solid State Reaction Synthesis and Characterization of Cu doped TiO_2 Nanomaterials", In Journal of Physics: Conference Series, IOP Publishing, (2021), in press.

[39] M. M. Abbas and M. RASHEED, "Investigation of structural, Mechanical, Thermal and Optical Properties of Cu Doped TiO_2", Iraqi Journal of Physics (IJP), (2020), in press.

[40] M. Rasheed, and R. Barillé, "Comparison the optical properties for Bi2O3 and NiO ultrathin films deposited on different substrates by DC sputtering technique for transparent electronics", Journal of Alloys and Compounds, vol. 728, (2017), pp. 1186-1198.

[41] M. Rasheed, and Régis Barillé, "Optical constants of DC sputtering derived ITO, TiO2 and TiO2: Nb thin films characterized by spectrophotometry and spectroscopic ellipsometry for optoelectronic devices", Journal of Non-Crystalline Solids, vol. 476, (2017), pp. 1-14.

[42] M. RASHEED, S. SHIHAB and T. RASHID, "Parameters Determination of PV Cell Using Computation Methods", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 1-9.
[43] M. Rasheed, S. Shihab, O. Alabdali and H. H. Hussein, "Parameters Extraction of a Single-Diode Model of Photovoltaic Cell Using False Position Iterative Method", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.
[44] M. RASHEED, S. SHIHAB, and O. W. Sabah, "An investigation of the Structural, Electrical and Optical Properties of Graphene-Oxide Thin Films Using Different Solvents", In Journal of Physics: Conference Series. IOP Publishing, (2021), in press.
[45] N. B. Azaza, S. Elleuch, M. Rasheed, D. Gindre, S. Abid, R. Barille, Y. Abid, and H. Ammar, "3-(p-nitrophenyl) Coumarin derivatives: Synthesis, linear and nonlinear optical properties", Optical Materials, vol. 96, (2019), pp. 109328.
[46] T. Saidani, M. Zaabat, M. S. Aida, R. Barille, M. Rasheed, and Y. Almohamed, "Influence of precursor source on sol–gel deposited ZnO thin films properties", Journal of Materials Science: Materials in Electronics, vol. 28 (13), (2017), pp. 9252-9257.
[47] W. Saidi, N. Hfaidh, M. Rasheed, M. Girtan, A. Megriche, and M. EL Maaoui, "Effect of B2O3 addition on optical and structural properties of TiO2 as a new blocking layer for multiple dye sensitive solar cell application (DSSC)", RSC Advances, vol. 6 (73), (2016), pp. 68819-68826.
[48] M. RASHEED, "Investigation of Solar Cell Factors using Fuzzy Set Technique", Insight-Electronic, vol. 1 (1), (2019), pp. 17-23.
[49] M. Rasheed, and M. A. Sarhan, "Characteristics of Solar Cell Outdoor Measurements Using Fuzzy Logic Method", Insight-Mathematics, vol. 1 (1), (2019), pp. 1-8.
[50] M. RASHEED, S. SHIHAB, T. RASHID, "Two Step and Newton- Raphson Algorithms in the Extraction for the Parameters of Solar Cell", Al-Qadisiyah Journal of Pure Science, (2021), in press.
[51] M. RASHEED, and M. A. Sarhan, "Measuring the Solar Cell Parameters Using Fuzzy Set Technique", Insight-Electronic, vol. 1 (1), (2019), pp. 1-9.
[52] M. S. Rasheed, "An Improved Algorithm For The Solution of Kepler's Equation For An Elliptical Orbit", Engineering & Technology Journal, vol. 28 (7), (2010), pp. 1316-1320.
[53] M. S. Rasheed, "Approximate Solutions of Barker Equation in Parabolic Orbits", Engineering & Technology Journal, vol. 28 (3), (2010), pp. 492-499.
[54] M. S. Rasheed, "Comparison of Starting Values for Implicit Iterative Solutions to Hyperbolic Orbits Equation", International Journal of Software and Web Sciences (IJSWS), vol. 1 (2), (2013), pp. 65-71.
[55] M. S. Rasheed, "Fast Procedure for Solving Two-Body Problem in Celestial Mechanic", International Journal of Engineering, Business and Enterprise Applications, vol. 1 (2), (2012), pp. 60-63.
[56] M. S. Rasheed, "Modification of Three Order Methods for Solving Satellite Orbital Equation in Elliptical Motion", Journal of university of Anbar for Pure science, vol. 14 (1), (2020), pp. 33-37.
[57] M. S. Rasheed, "On Solving Hyperbolic Trajectory Using New Predictor-Corrector Quadrature Algorithms", Baghdad Science Journal, vol. 11 (1), (2014), pp. 186-192.
[58] M. S. Rasheed, "Solve the Position to Time Equation for an Object Travelling on a Parabolic Orbit in Celestial Mechanics", DIYALA JOURNAL FOR PURE SCIENCES, vol. 9 (4), (2013), pp. 31-38.
[59] M. RASHEED, Osama Alabdali, S. SHIHAB and T. RASHID, "Evaluation and Determination of the Parameters of a Photovoltaic Cell by an Iterative Method", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 34-42.
[60] R. I. Sabri, M. RASHEED, O. Alabdali, S. SHIHAB and T. RASHID, "On Some Properties in Fuzzy Metric Space", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 55-61.
[61] M. N. Mohammedali, M. RASHEED, S. SHIHAB and T. RASHID, "Fuzzy Set Technique Application: The Solar Cell", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 62-69.
[62] R. J. Mitlif, M. RASHEED, S. SHIHAB and T. RASHID, "Linear Programming Method Application in a Solar Cell", Journal of Al-Qadisiyah for Computer Science and Mathematics, vol. 13 (1), (2021), pp. 10-21.
[63] M. A. Sarhan, S. SHIHAB, M. RASHEED, "A novel Spectral Modified Pell Algorithm for Solving Singular Differential Equations", Al-Mustansiriyah Journal of Science, vol. 32, (1), (2021), In press.