Chapter

Functioning Fuzzy Logic in Optimizing the Solar Systems Work

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Abstract

Fuzzy logic has been used in many fields, either to control a specific movement, improve the productivity of a machine, or monitor the work of an electrical or mechanical system or the like. In this chapter, we will discuss what are the basic factors that must be taken to use the fuzzy logic in the aforementioned matters in general, and then focus on its employment in the field of renewable energy. Three main axes for renewable energy are solar panels, a wind turbine and finally, solar collectors. The key to working and the basis of the static system is the mechanism for selecting the inputs that directly affect the output in addition to the methods and activation functions of the fuzzy logic.

Keywords: renewable, energy, solar panals, effeciency and optimization

1. Introduction

In this chapter a complete review of how the fuzzy dominant operates in renewable energy, analyzes, and control. Usually many of the words which are used arbitrarily in our lifestyle have a simple meening and big work. When representing or discus a system or any think, words were used such as big, small, long, short, cold, warm, hot, sunny, cloudy, fast, slow, etc., which are vague in nature. Humans are use unguaranti, catchy and muddy words when showing something or report a decisions to produce a certain actions. According the age, call were individual old, mid-age, young, old plus, and new young. Applying gas or stop pressure according to road situation, whether dry, slippery, sloping or flat. If the light level in the classroom is low, we increase the brightness with one touch, otherwise, we decrease it. These examples illustrate how our brain behaves and makes decisions during uncertain and ambiguous situations.

Studies of systems with unconfirmed and disinformation have reached the era of substitution with the submitting the article "Fuzzy Groups" by Lotfi Zadeh [1]. Although this text was first published in 1965, the use of Symbolic Logic (FL) increased after the latter half of the 1970s when Lotfi A. Zadeh two additional articles [2, 3], in which pure fuzzy mathematics was used for uncertain systems and decision making. FL apps have been gaining fast speed since the Japanese started using them in commercially available devices. Nowadays, it is possible to search for ambiguous applications in almost every region [4]. Depending The sustainable sources are containes more parameters and variables which difficult to control, but using the artificial intellignt make the contol simple and easy to use. FL works in many areas of use for automatic control systems and monitoring issues [4–7]. It can be used in database control tool to manage the data flow and knowledge, huge data, innovative method, and smart work for the motors. Graphical works, signal prob., and body-motor simulation are also another applications where FL is function. Additionally, fuzzy is utilized as a mathmatics processor in some cases such as equation optimization, selecting, figures smoothing, etc. [4].

In this chapter, the mechanism of programming and designing mechanisms for improving the work of solar energy systems will be explained and how to make the most of their work. As for solar cells, as it is known, they have several uses, including: converting solar radiation into electrical energy, distillation, storage, heating water and so on from these applications. The initial design of these systems may be with a certain efficiency or at a specific degree of use with specific physical or material matters, here comes the role of methods for improvement, searching for weaknesses and addressing them in systems in general and solar systems in particular. Artificial intelligence, it has been used by many researchers in improving the work of solar systems in terms of increasing efficiency and choosing the values of the best variables at different times of the day in which the intensity of solar radiation, inclination angle, humidity, and the like changes.

The optimization process for the operation in general is based on the mathematical model reached in the initial design of the system. In an AI environment, the default system inputs are identified with the expected output of these inputs. When the ideal result for the system is available, the proposed controller, which is built on the basis of artificial intelligence, changes the internal factors of the system and adjusts the initial weights to make the general system work according to the expected standards and the productivity, as far as possible, is ideal.

2. Fuzzy sets

Fuzzy groups are the basic elements of FL. Fuzzy groups are characterized by organic functions. In fact, these organic functions are just kind of mysterious numbers. One must know the meaning of ambiguity in order to know the terms FL, membership function, and ambiguous number. For example, two specific colors are mixed in the color world and they appear in **Figure 1**. First, it's white, and then it's

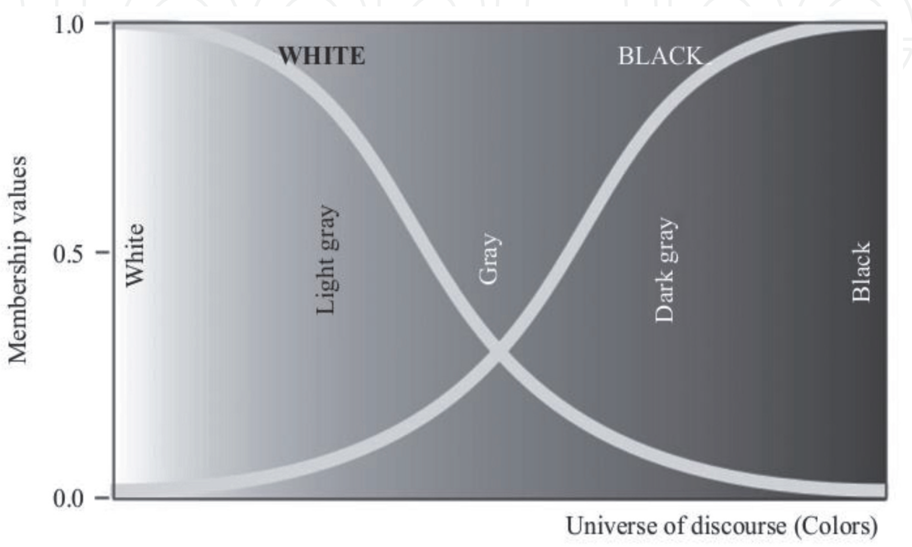

Figure 1.
Blended colors in the universe of colors.

changed to black over a transition area so that it becomes light gray, gray, taupe, and black as we move from left to right. It is not a single color that is transparent in transition. Includes a black and white reminder and no one can distinguish one color from the other because the transitional part is blurred. Colors within the transition region are often highlighted as white, light gray, gray, dark gray, and black shown in **Figure 1**.

There are two color classes in **Figure 1**, black and white, called fuzzy subsets or fuzzy organic functions. The Fuzzy subset WHITE in **Figure 1** shows the tones that are white while the blur The BLACK subset represents the black hue. The prolonged changing zone, the tow different colors. The color is different from the two origin. The color range along the line is blurred. FL is used in the search for solutions in the common areas between ideal solutions and wrong solutions, and for this, the search process may produce unexpected and unexpected solutions. Most of the researchers used fuzzy logic to improve the productivity of a machine or improve the efficiency of a specific system or the like, due to the rule that this type of research is characterized by, in foggy areas, which allows the system to use solutions closer to reality than it was in the past. In mathematical equations, an example of the above, there is one or two roots in most possibilities. When using fuzzy logic, it will find a set of roots that give a much lower error rate which depends on the permittivity specified in the software.

2.1 Fuzzy membership functions

The functions of FMF can be seen as a tunnel between unconfirmed bits and a hazy outland. The fragile home of muddy information is subdivided and shown by unclear organic form, see **Figure 2**. Shades of gray become darker as we move from left to right or from white to black. Semi-color of gray were re-arranged into subsections as high, little high, low, very low and zero refered by the triple-kind mysterious organic method [1].

The organic function is the basis for the system modeling process in order to improve its operation or reduce the error rate. Where the number of functions must be determined with the quality of each function and according to the data that will be dealt with. There are linear and nonlinear models, each of them has a function quality that differs from the other, in order to reach the goal more quickly and accurately than is recognized. The organic functions that distinguish fuzzy groups and the groupings with which they are performed are the idea of fuzzy sets and systems of symbolic logic. Therefore, understanding ambiguous groups and their groupings is vital to understanding what is often done with fuzzy sets and symbolic logic. Therefore, this chapter is reserved for introducing ambiguous groups and

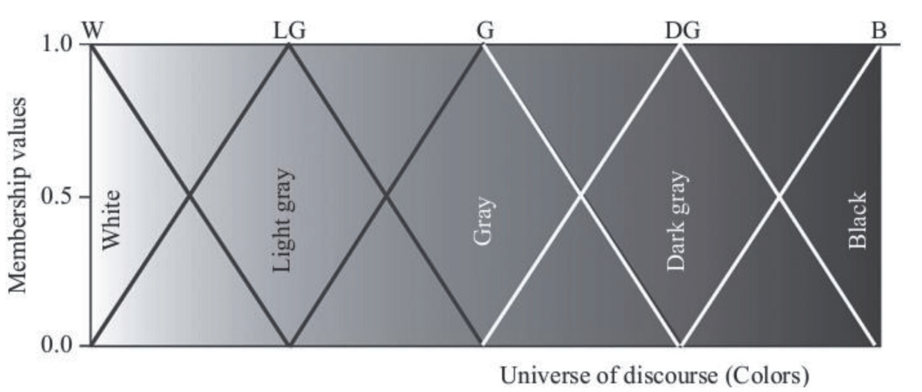

Figure 2.
Blended colors in the universe of gray colors.

analyzing their properties from a control application point of view. Known membership functions will be reviewed to represent fuzzy groups one by one, and MATLAB functions for each will be written as a neighborhood to develop a symbolic, logical, user-defined toolbox.

3. Photovoltaic

Photovoltaics has become the most cost-effective source of electrical energy in regions with high solar potential, with bids as low as $ 0.01567/kWh [8] in 2020. Panel prices have decreased 10 times in a decade. This competitiveness opens the way for a global transition to sustainable energy, which may be needed to help mitigate heating. Emissions of carbon dioxide allow the achievement of a target of 1.5 degrees that will be spent in 2028 if emissions remain at the current level. However, using photovoltaic energy as a first supplier requires a power saver or main divider by a big energy DC busses which adds fees.

Solar PV has some impoertant benifet as an power supply: when first operate, its response produces no infection and no emissions of cleanhouse gases, it is additionally viewed in terms of energy is widely available within the shell. Photovoltaic systems have always been used in specialized applications where standalone installations and grid-connected PV systems have been used since the 1990s [9] PV modules were first produced in large quantities in 2000, when German environmental scientists, and thus Eurosolar, obtained government funding for the Ten Thousand Roofs program [10].

4. Application of fuzzy logic in solar system optimization

Before starting with the details of this application, we will mention the basics followed to represent the solar system and what are the most important variables that must be followed to improve work and make the most of it.

The solar radiation which received by the solar still was calculated using ASHRIE model depending on the environmental conditions in Iraq (35.33No, 44.5 Eo) due to lack of Meteorological data.

The intensity of total solar radiation incident on inclined plane by δ angle was calculated using the following formula:

$$I_o = I_{DN} * \left[\cos(\theta) + C * \frac{(1 + \cos\delta)}{2} + s * (C + \sin\beta) * \frac{(1 - \cos\delta)}{2} \right] \quad (1)$$

where: I_{DN} represents the amount of direct radiation incident on the perpendicular surface and calculated from the following equation:

$$I_{DN} = A_1 \exp\left(-\frac{B}{\sin(\beta)}\right) \quad (2)$$

A1 is the intensity factor of solar radiation and calculated from the following relationship:

$$A_1 = 1158 * [1 + 0.066 * \cos(360 * ND/370)] \quad (3)$$

B is the atmospheric extinction coefficient calculated according to the following equation:

$$\begin{aligned} B = 0.175 * [1\text{-}0.2 * \cos(0.93 * \mathrm{ND})] \\ -0.0045 * [1 - \cos(1.86 * ND)] \end{aligned} \tag{4}$$

s the quantity of reflective ground referred to as (Alpedo) with an estimated value adequate to 0.25 within the current research.

β is an angle calculated due to sun radiation.

C is a factor can determined by:

$$\begin{aligned} C = 96.5 * 10^{-3} * \left[1\text{-}0.42 * \cos((0.97) * \text{number of days})\right] \\ -7.5 * 10^{-3} * \left[1 - \cos(1.95 * \text{number of days})\right] \end{aligned} \tag{5}$$

θ is an angle determined by:

$$\cos\theta = (\sin(beta) * \cos(segma) \pm \cos(beta) * \cos(phai) * \sin(segma)) \tag{6}$$

φ is the angle between projection of rays on the surface and vertical line on the surface, called the surface azimuth angle and takes a negative signal if the surface tilted away from the sun.

ND Number of the day in the year.

To facilitate the mathematical analysis in question a set of assumptions were adopted, namely:

1. The heat transfer is one dimension through the transparent cover.

2. The temperature of the glass cover is constant.

3. Transparent cover reflects the infrared radiation.

4. Heat transfer is one dimension through the insulating layer.

5. The properties of various material not dependent on temperature.

According to the assumptions above, we can write the heat balance equation of solar still as:

$$C_s \frac{dT_w}{dt} = (\alpha_g + \alpha_w \tau_g) I_o - q_{ga} - q_b - q_f \tag{7}$$

where C s is the heat capacity of the solar still, including the heat capacity of water-gravel layer, the glass cover and the structure of still. While the water and gravel in the basin occupy a certain space of each other and changing in so-called porosity factor that has the symbol (ϕ) Which represents the volume of water relative to the total volume, the water mass is (mw) and the gravel mass (ms) under the following equations:

$$\begin{aligned} m_w = V_t \phi \rho_w \\ m_s = V_t (1 - \phi) \rho_s \end{aligned} \tag{8}$$

The intensity of gravel used 2560 kg/m 3 and specific heat capacity is equal to 900 J/kg.K [11].

Thermal equilibrium of still glass cover was given by the following relationship:

$$q_{ga} = q_r + q_c + q_e + \alpha_g I_o \tag{9}$$

Heat is transported across the bulk of the humid air inside the sill by free convection of air between the water surface and the cold glass cover. Khalil and Al-Jibouri [12] estimated the transmitted heat (watts per square meter of glass surface) using the following formula [12]:

$$q_c = 0.8831\left[\left(T_w - T_g\right) + \frac{P_w - P_{wg}}{0.265 - P_w}\left(T_w + 273\right)\right]^{1/3}\left(T_w - T_g\right) \tag{10}$$

where T w and T g is the average temperature for the mixture of water - gravel and glass cover used, respectively.

P_w and P_{wg} the vapor pressure (Absolute MPa) at temperature Tw and Tg, respectively, calculated from the following formula:

$$\begin{aligned}\log_{10} P_w = &-3.2154 + 3.13619 \times 10^{-2} T_w - 1.22512 \times 10^{-4} T_w^2 \\ &+3.6384 \times 10^{-7} T_w^3 - 5.67607 \times 10^{-10} T_w^4\end{aligned} \tag{11}$$

A hot air carrying water vapor from the warm water surface on the base of the still to the inner surface of the cold glass covered causing condensation on it, the estimated internal rate of heat transfer intensification (qe) (watts per square meter) of the following equation [13]:

$$q_e = 0.0061\left[\left(T_w - T_g\right) + \frac{P_w - P_{wg}}{0.265 - P_w}\left(T_w + 273\right)\right]^{1/3}\left(P_w - P_{wg}\right)L_w \tag{12}$$

Where L_w is the latent heat of evaporation at water temperature (Tw) of still calculated by the following formula:

$$L_w = 2501.67 * 10^3 - 2389 T_w \tag{13}$$

And the rate of condensate water (per square meter of glass cover) calculated from the following formula:

$$D_e = \frac{q_e}{L_{w,g}} \tag{14}$$

$L_{w,g}$ is the latent heat of water vaporization at glass temperature (Tg.).

Also the heat is transferred by radiation between water surface and the glass cover an estimated rate of transmission in this way is as follows:

$$q_r = F\sigma\left[\left(T_w + 273\right)^4 - \left(T_g + 273\right)^4\right] \tag{15}$$

where σ is Stefan-Boltzmann constant and the supposition of the small distance between the water surface and glass cover, compared with the length and width of still, the surfaces can be considered as an infinite and the shape factor computes from the following formula:

$$F = \frac{1}{\frac{1}{\varepsilon_g} + \frac{1}{\varepsilon_w} - 1}. \tag{16}$$

where ε_g and ε_w the emissivity of the inner surface of glass cover and water, respectively.

The glass cover loses heat to the outer surrounding by convection and radiation together and the lost heat calculated from the following formula:

$$q_{ga} = h_{ga}(T_g - T_a) + \varepsilon_g \sigma \left[(T_g + 273)^4 - (T_{sky} + 273)^4 \right] \quad (17)$$

where h_{ga} is the convection heat transfer coefficient between the outer surface of the glass cover and ambient air is highly dependent on wind velocity using the following formula to calculate this factor [10]:

$$h_{ga} = 5.61 + 1.09v \text{ where } v < 18. \quad (18)$$

$$h_{ga} = 2.64 * v^{0.78} \text{ where } 18 \le v \le 110 \quad (19)$$

where v is wind velocity, and given in units of (km/hour).

T_{sky} is the apparent sky temperature and calculated from the following equation [14]:

$$T_{sky} = 0.0552 * (T_g + 273)^{1.5} - 273 \quad (20)$$

The bottom and sides of solar still were insulated to minimize heat loss to the external environment and an estimated rate of heat loss of the solar still base per square meter of glass cover from the following relationship:

$$q_b = U_b(T_w - T_a) \quad (21)$$

where U_b is the overall coefficient of the transfer of rear heat through the base of still, calculated by the following formula:

$$\frac{1}{U_b} = \frac{t}{k_b} + \frac{1}{h_b} \quad (22)$$

where t is the thickness of insulation, and k is thermal conductivity of insulation material, h_b the transfer coefficient of the lower side of still.

If the feeding system continues to feed the water into the solar still, heat amount depleted as a result of this feeding calculated by the following formula:

$$q_f = G_f c_p (T_w - T_{f,i}) \quad (23)$$

where G_f feeding rate per square meter of the glass cover and c_p the heat capacity of feeding water, $T_{f,i}$ the temperature of feeding water interring the still usually taken equal to the temperature of the atmosphere in the first hours of the day.

In this sectio, tow implemented works were fixed to show how the fuzzy optimiz the overal system performance.

4.1 Hybrid solar collector

In this application example, we will explain how to take advantage of the fuzzy controller to improve the efficiency of a solar collector with three thermal complexes, as the necessary parameters for each complex were determined and then installed on a software model to be in harmony with what is logical and ideal.

In **Figure 3**, with the aim of comparing the thermal and electrical performance of a hybrid solar panel, each model consists of most of the parts:

Hybrid collector base (Iron Stand)

The wooden structure

Solar cells

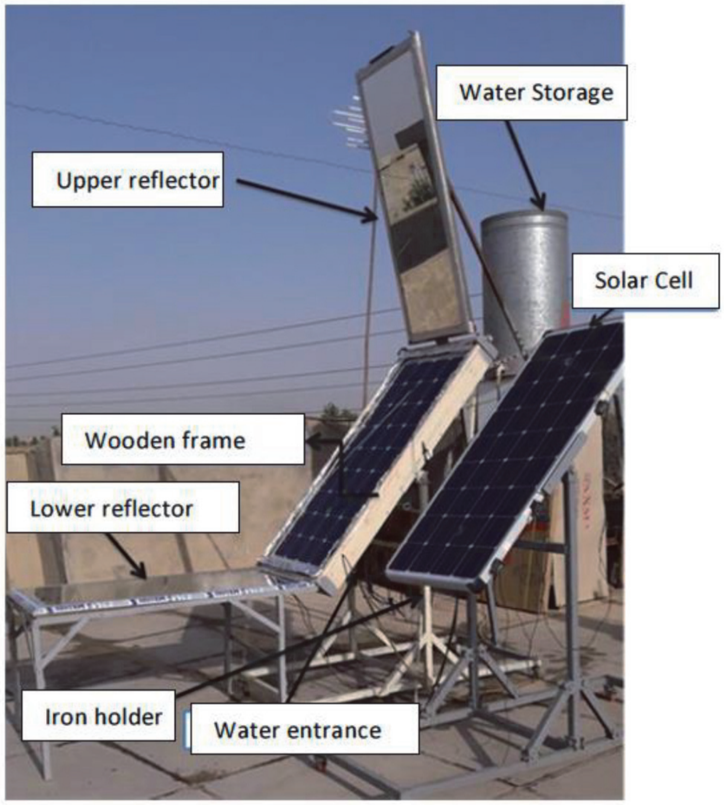

Figure 3.
A photograph of the hybrid solar collector used.

Reflective mirrors
Measuring devices

The first model consisted of a monocrystalline photovoltaic cell, described in **Table 1** inside the wooden structure and the photovoltaic cell housed within a wooden structure, isolated from the back and sides by a solid insulation. The device shown in **Figure 3** is behind the photovoltaic cell, fix the glass cover over the PV cell 2.5 cm away. Use a lower mirror with dimensions (length 120 cm, width 50 cm) on the top of a solar panel. Iron holder is for this bottom mirror. This stand is mounted on the iron stand of the solar dish. They are often moved by different angles of the solar thermal collector and thus have the same dimensions as the bottom mirror and the reflectivity of those mirrors estimated at 0.95. Mirror edges surround an aluminum frame to secure it and make sure not to break it. The second model might be a photovoltaic cell without refrigeration (it has no device below) and has no solar mirrors installed on it. The aim of constructing a symmetric model is to achieve an accurate comparison of the effect of design and operating variables affecting the performance of the hybrid solar panel to succeed in the acceptable range of this case. Many kind of recording devices have been fixed to determine temp. a variety of thermocouples were created to live the temp. in several regions of validation.

These parameters are fixed within devices, hence FL is used for control issue. Three entrances are defined as PV / T corner, mirror (upper corner) and lower

V.\I/P	No. of atte.	Temp. (°C)	I (W/m^2)
Simple	S-u	L-t	L-i
Med	M-u	M-t	M-i
Big	L-u	H-t	H-i

Table 1
The linguistics term for the FL input.

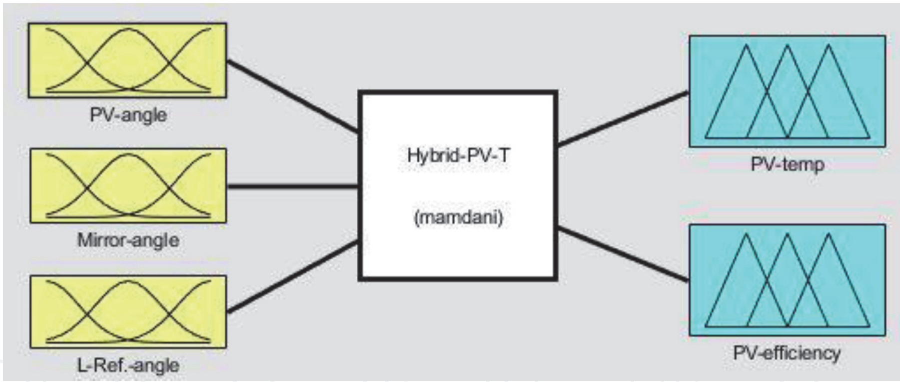

Figure 4.
The FL system architecure.

reflector angle. Draw outputs are monitored to optimize system efficiency, PV/T temperature and power generation, see **Figure 4**. Mamdani model was used to optimizing the proposed system with three inputs and two pairs of outputs. However, FL controls the sun's radiation and thus the amount of water needed by the collector.

The function of the MF member vessel is determined according to the nature of the information for each part of the system. Therefore, the amount of MFs is fixed to three for both input and output, in addition to the present, the amount of bases has reached approximately 3 * 3 * 3 27. Use the solar density meter (solar meter SM206) to accurately live the radiation intensity (± 10 W/M2), the wind velocity was measured accurately (± 0.1%) so the instrument (MT- 1280) to live the voltage and current accurately (± 0.5 use 4 21 watts (DC)) lamps as the load of the photoelectric cell and a flowmeter for live water flow when entering the heat exchanger Behind the photovoltaic cell, **Figures 5** and **6** represent a diagram of the device used.

It is known that the solar cell produces electricity in the form of DC. When solar energy falls on the solar cell, electricity is produced by the positive and negative electrodes outside the cell. Its main advantages are that it does not contain moving parts that are subject to breakdown. The energy generated from the cell In this study according to the following equation.

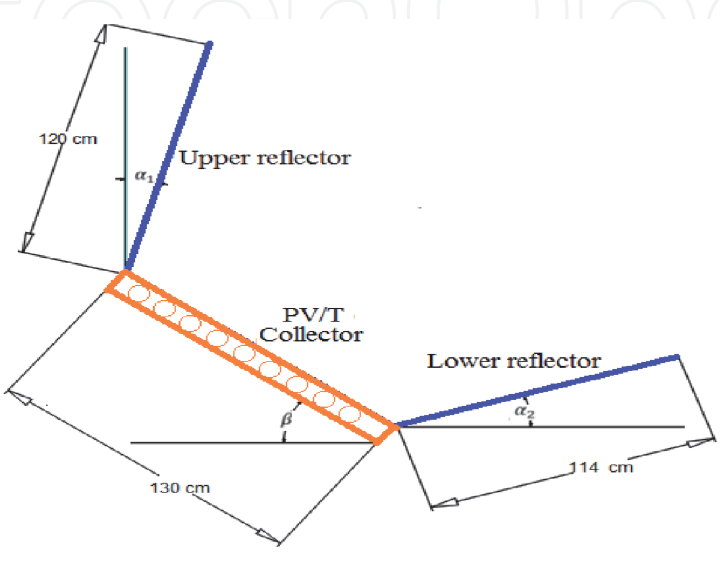

Figure 5.
Dimensions and angles of the mirrors used in the experiment.

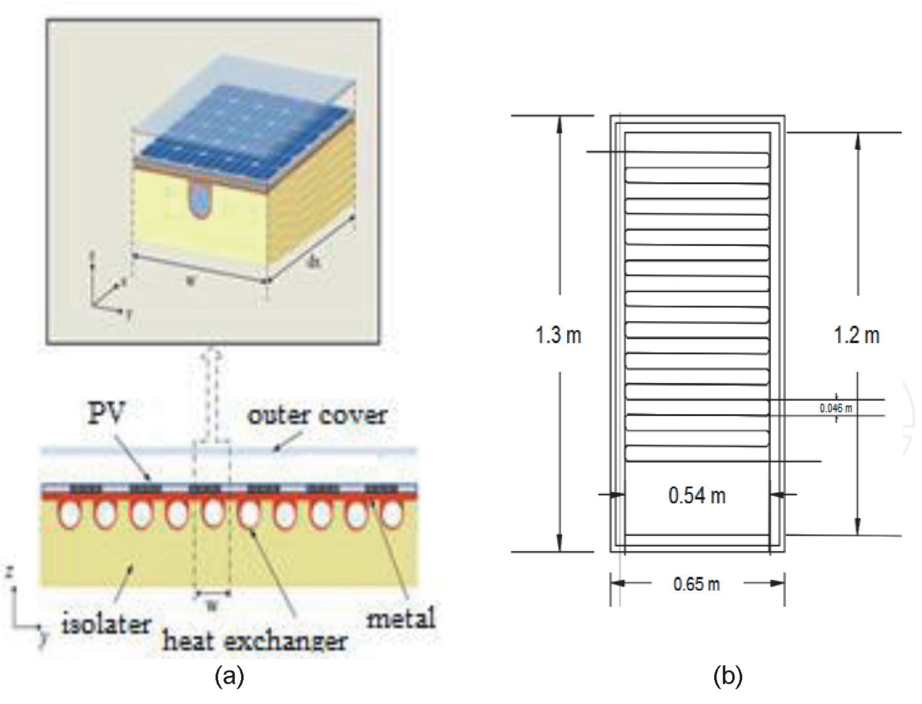

Figure 6.
A diagram of the parts of the solar collector (PV/T collector). (a) Side clip of solar cell and heat exchange. (b) Dimensions of heat exchanger.

$$P_{pv} = V * I \tag{24}$$

Where the represents current I and the voltage of the unit of the solar cell, each of which is measured using a device (Digital Scale), which is characterized by high accuracy of the measure of electricity (DC), and it is necessary that the measuring devices are accurate in order to calculate the efficiency and electrical power out of the solar cell to be correct And close compared to standard conditions specifications, see **Figure 7**.

The proposed of the solar dish fixed envolve of a photovoltaic and a device on second end photovoltaic cell. The proposed bowl is roofed with a single trnsparency layer. In addition, the top mirror is attached to the top and thus the below inverter is attached to the underside of the solar hybrid dish. **Figure 6** is a diagram of a hybrid solar dish.

The total radiation absorbed by the hybrid system connected to the upper and lower reflectors can be found from the following equation [15].

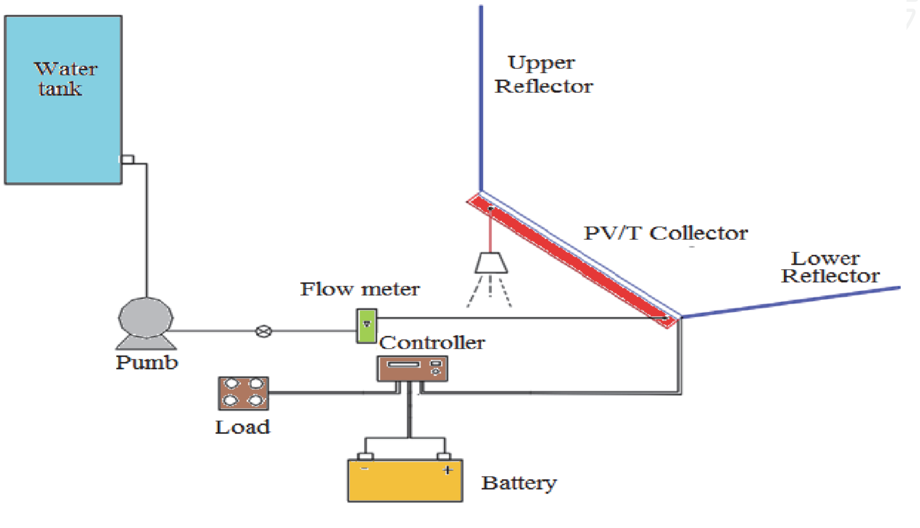

Figure 7.
The diagram of the device used.

$$A_{total} = A_b + A_d + A_g + A_{refr\ 1} + A_{refr\ 2} \tag{25}$$

Each part of the equation is found as follows [9]:

$$A_b = I_b R_b\ (\tau\alpha)_b \tag{26}$$

The below text can be reached (**Figure 8**):

The most applicable point during this thik is that the optimization, and thus the percentage became 84% after 66% in the old paper. Power production typically solar hybrid plate optimized with high value in the radiation by the reflecting plates, with the increase in the fluid flow without a transperant cover to prolong the cooling effect. Smart setting of system parameters with FL makes the system more installable and operating in optimum mode. Having both upper and lower external reflectors has a greater effect than having only one on the performance of a hybrid solar plate. The presence of dust negatively affects the performance of the hybrid solar dish and outdoor reflectors [12].

4.2 Special solar collector parameter determination

In this section, the symbolic logic of the angle organization and the total reservoir required for a particular place is also proposed due to the traditional tools of fresh water. Three inputs are defined for FL: indoor users, temp., and hence sun power; which varies from place to place and should be well fixed. The values of the input variables were transferred to the Linguistics model for better FL addition; This process is called fuzzification. Most of the parameters to be regulated within the wedge storage complex are the angle and size of the tank; These two things will be the FL output of (10°-85°) for angle, and (500-10000 L) for tank volume. The system was validated and tested by a combination of random value inputs and the output response monitored at the end of the system, when the users were around 20° C, so the density was 450 W/m2, and the output was 3560 liters for tank volume and 47.7° for angle. The control of the proposed system is straightforward to monitor and smooth transition within the output resulting in specification of parameters covering the full values available [16].

The proposed method for determining most of the stabilization parameters for storing the wedge assembly is based on FL. Throughout this paper, three method control inputs were defined to work on parameters defined for the new tank

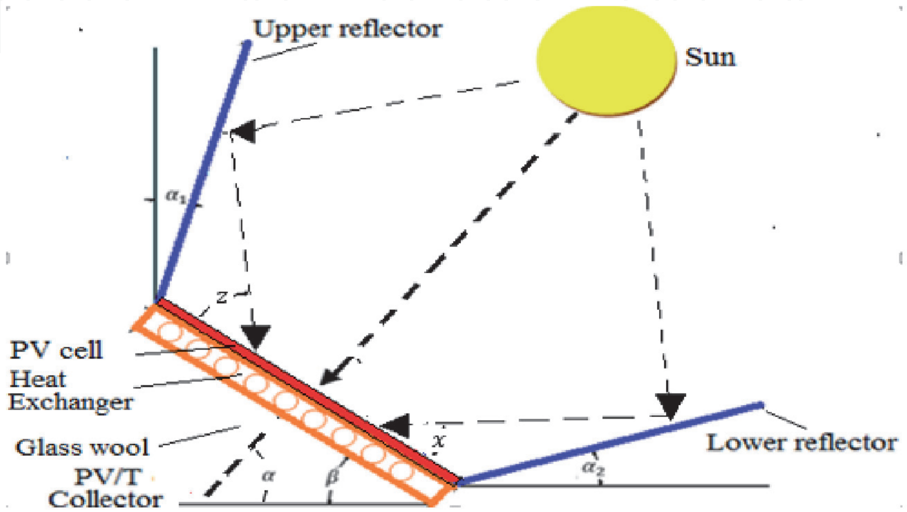

Figure 8.
Schematic of hybrid solar collector (PV/T).

geometry type. The input variables are: users inside the building, temperature, and thus daylight intensity, which are most of the FL inputs that are used to predict the response of the output. The range of the input data is: users inside the building (1–00), and the temperature inside the surrounding area is (10–60) degrees Celsius, so the intensity of daylight is (0–1000) W/m2 2. The specified input has a special range of values. And its unit which is one among FL facility points that may drive multiple types of knowledge. The basic step in FL is that of fuzzification, which proposes converting numeric data into linguistic variables for each input. 3- Membership function (MF) for each input variant and each Gaussian MF to overcome nonlinear changes within the input file. **Table 1** shows linguistic terms derived from the names of the input variables.

Due to these language words; The fussy will derive the monitor signal to the machine through a Mamdani process. Values within the input range will be validated, not normal or rearranged by alternate model, because they are within real model to meet optimal work with very small error ratio. When the information is set up through a process of scrambling, the inference engine will drive the control flow through well-established rules that support the state of the input values. The rule-base is often represented by an unclear factor to provide the specific response consistent with the mathematical model of system control. The amount of rules for each ambiguous project is often determined by keeping the MF amount to the input count power; Eq. (2) is often used for this purpose [17, 18]:

$$\boldsymbol{rules_{project}} = \left(\boldsymbol{n_{inputs}}\right)^{n_{MF}} \tag{27}$$

In this work 3-MF is installed on the input and there are 3 input variables; This indicates that 27 is the maximum number that is often reached to take care of the control process. The operator drives things to meet the optimum system response and control the conditions available to the input variables. A list of some derivative rules for the current issue throughout this paper is explained below, clear to ascertain the fuzzy operator and to force all three input values available in the current data to work on the specified parameters of the wedge complex:

1. If (UserNum is S-u) and (Temp. is L-t) and (I is L-i) then (TankS is M-T) (CutAn is L-A)

2. If (UserNum is S-u) and (Temp. is M-t) and (I is M-i) then (TankS is S-T) (CutAn is M-A)

3. If (UserNum is S-u) and (Temp. is H-t) and (I is H-i) then (TankS is S-T) (CutAn is S-A)

4. If (UserNum is S-u) and (Temp. is L-t) and (I is M-i) then (TankS is S-T) (CutAn is M-A)

5. If (UserNum is S-u) and (Temp. is H-t) and (I is H-i) then (TankS is S-T) (CutAn is S-A)

MF is 3 for all parameters and Gauss for non-linear process and is closest to the active response. **Figure 2** shows the curves of the member-ship for each proposed FL model with the general block of the manager board (**Figure 9**).

FL response is often examined either during curves or by adjusting the input value through principles and observing the output response. Throughout this paper, both types of results are fixed to further validate the proposed work and

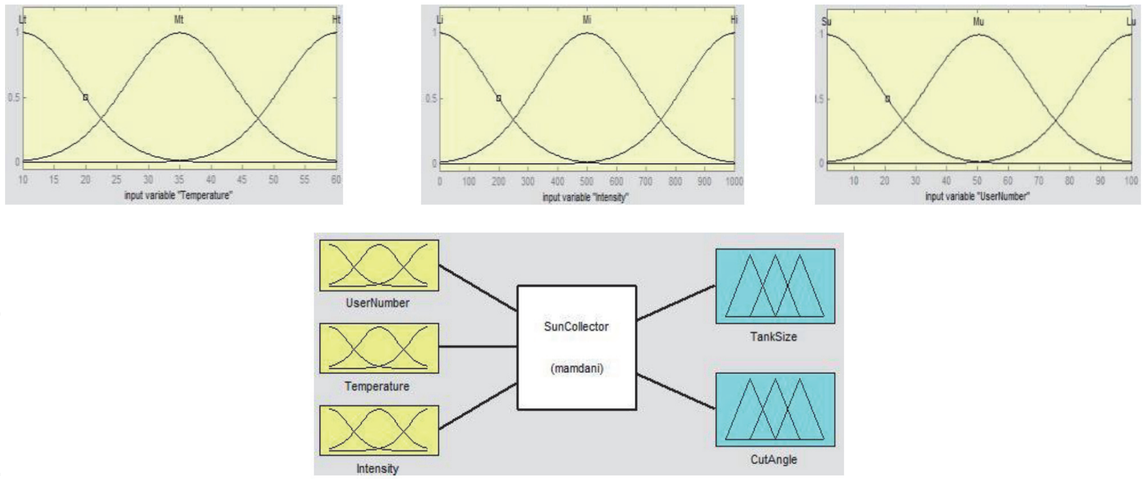

Figure 9.
The MF for the i/p points with the rest.

demonstrate how the input affects the specific parameters of the system. **Figure 10** shows the determined surface response to the number of users and temperature with an indication of the collector volume in liters.

In this figure, it is evident to ascertain the transition response when the input varies from low to high values and thus the output increases or there is still change in both cases. The surface corresponding to the temperature and intensity with reference to the volume of the tank is shown in **Figure 11**.

The tank volume is particularly related to the number of users inside the building, and the opposite input variables have little influence on it, so the values are arranged between 5498 and 5499 liters. The reason for the agile transition within the output response in **Figures 4** and **5** is to facilitate the proposed control method that deals with the smallest change within the data entry. For example; When the number of users is low (7), the temperature is medium (27° C) and the intensity is low (200 W/m2); Expected parameters for FL are: 2,240 liters for tank volume and 74.7 liters for angle. The size of the tank mainly depends on the number of users, and the other has a touch effect on it.

In **Figure 12**, the relationship between users and density is shown with respect to tank volume. Clear to ensure the transmission of values is consistent with the state of the entry.

When cutting is the most respected variable, the response will be more realistic and have little change as data entry increases or decreases. The angle varied

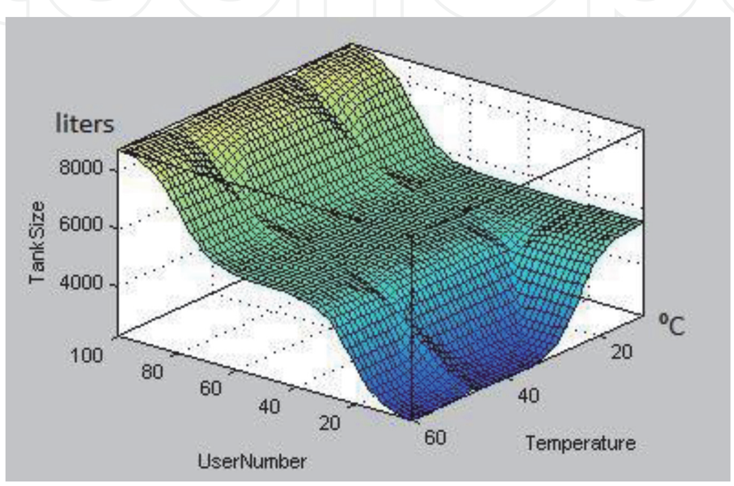

Figure 10.
The response of the proposed control system for the users and temps.

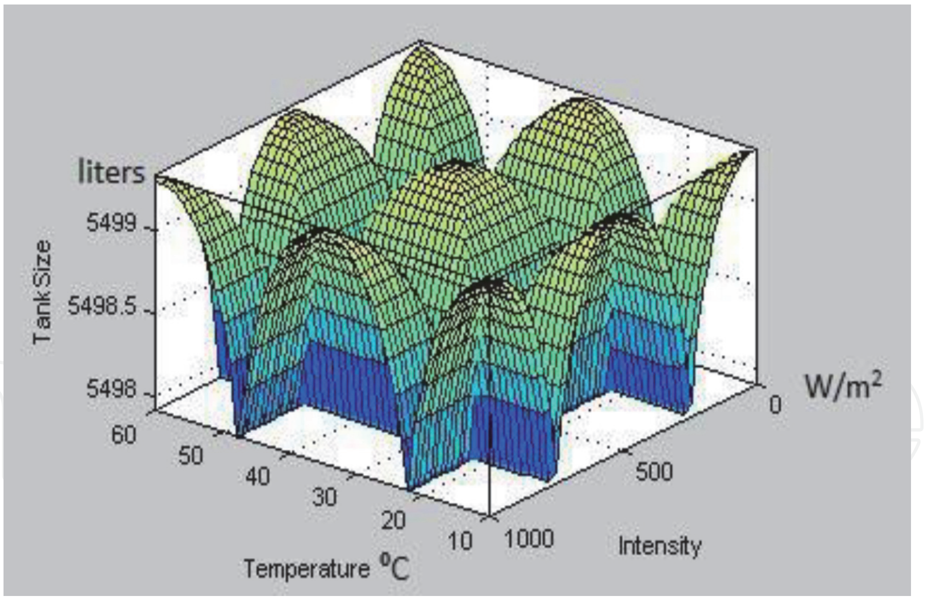

Figure 11.
The output surface response for the temperature and intensity with respect to tank size.

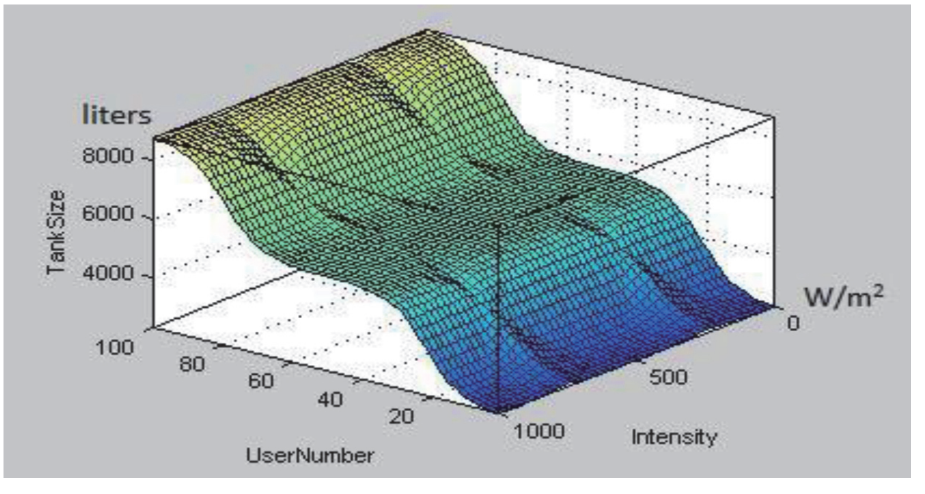

Figure 12.
Tank size response according to resent user ans intensity numbers.

according to the strength of the candle and the temperature values which would reflect the good design of the proposed method. When the temperature and intensity are at the maximum values, the angle will be 45 degrees; Otherwise, the angle begins to expand to collect optimum sunlight.

FL may be an instrument that simplifies the control problem by means of a simple and real response with very slight actuators [17]. During this work, FL identifies and compares different types of temperatures and the number of users for their service with appropriate storage of the wedge complex. The input variables are: users inside the building, temperature, and thus daylight intensity, which are most of the FL inputs that are used to predict the response of the output. Whereas there are two output variables: tank size and hence cut angle; Which are the wedge storage complexes. During a particular situation; When the number of users is low (7), the temperature is medium (27° C) and the intensity is low (200 W/m2); Expected parameters for FL are: 2,240 liters for tank volume and 74.7 liters for angle. FL gives different values when input file variables are changed or a new building must be constructed in a new location. The control of the proposed system is straightforward to monitor and smooth transition within the output which results in specification of parameters covering the full available values. When the specified

DOI: http://dx.doi.org/10.5772/intechopen.97107

values are applied to the actual design of the collector store, there is approximately 25% improvement share for the water system. The proposed control satisfies the corner rule for storing the collector which has an inverse relationship to the radiation.

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