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IMPLEMENTATION OF SOLAR AND WIND ENERGY BY RENEWABLE ENERGY RESOURCES WITH FUZZY LOGIC

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Abstract- Today, due to the end of fossil fuels and the increase in environmental problems and costs they have created, energy resources production techniques etc. causing them to be re-examined. Environmental problems such as air pollution, global warming, soil and water pollution that are generated during the production of energy from fossil fuels are increasing day by day. Renewable energy sources need to be exploited to address these problems and to reduce the increase in production and transmission costs. Solar and wind are the major and renewed sources of renewable energy sources, with the largest and cleanest of all available energy sources. In this study, a system implementation was introduced to make the solar panels and wind roses used to convert solar and wind energy into electricity more efficient. It is aimed to increase efficiency by positioning panels and wind roses at different sides of the sun and wind. PID controllers that control the elements in the system are used. For the decision mechanism of the system, fuzzy logic is chosen. Fuzzy logic technology allows electronic systems to operate with expert judgment, especially in the field of control. Seven sensors, panel and wind rose positioning information in the system entrance are sent to the micro controller on the control card. Thus, with the help of step motors, the solar panel, which converts solar energy into electrical energy, has been provided with more electricity by positioning the wind laughter that turns the wind energy into electrical energy.

Keywords: Fuzzy Logic, Solar Panels, Wind Rose, Step Motors.

I. INTRODUCTION

Renewable energy is seen as an important resource in meeting the energy demand in the world. The development use and development of energy resources that have priority in terms of the development and future of our country [1]. A long-term energy planning and management is required for diversification. Many countries out the renewable energy such as solar energy, geothermal energy, wind energy, which will reduce dependence to a minimum level energy sources, the most effective and widespread use of these resources in Turkey. It is necessary to provide knowledge that includes new technologies and applications for the progress of the process [2].

Solar Power Plants are photovoltaic electricity power plants with solar energy batteries that are created by bringing together a large number of solar panels. Solar power plants that generate renewable electricity are a type of energy that can be installed and operated with the aim of providing energy for residential units and supporting additional power to the city grid [3]. Energy from the sun; electricity is converted into electric energy with units named as photo voltaic, solar panel, solar panel, solar battery, solar batteries, PV, module, solar module, solar cell [4].

The first energy obtained from the sun is dc direct current electricity. This dc direct current electricity can be used in homes and factories by converting the ac alternating current energy into alternating current in switching areas [5]. Wind energy, on the other hand, is the kinetic energy of the air in motion, first of all mechanical energy and then of electricity [6]. Wind turbines are manufactured with horizontal axis or vertical axis according to the direction of rotation axis [7].

The most common types of these types are horizontal axis wind turbines [8]. Horizontal axis wind turbines operate with their axis of rotation parallel to the wind direction and their wings perpendicular to the wind direction [8]. Such wind turbines are constructed with one, two, three or many wings [9]. In this study, it was aimed to produce more electric energy by changing the position of the solar panels and wind roses used for converting solar and wind energy to electricity energy by developing a hybrid energy system based on solar and wind. This system implementation with fuzzy logic has been developed.

II. FUZZY LOGIC CONCEPT

Fuzzy logic is based on fuzzy set and sub set. In a classical approach, an entity is a member of the coop or is not. When expressed mathematically, "1" is the value when the element is a member of the conglomerate, and "0" when the element is not a member of conglomerate.

Fuzzy logic is the extension of classical cluster representation [10]. Each entity in the fuzzy entity set has a membership level. The membership level of entities can be any value in the interval (0, 1) and the membership function is denoted by $M(x)$. As we can see in Figure 1, for example, if we assume that the normal room temperature is 23 degrees, we consider the temperature gradients over 23 degrees according to the classical cluster theory to be warm, and the membership grades in the warm cluster of these grades becomes "1" [11].

The temperature grades below 23 are cold and the membership grades in the hot cluster are "0". These values are reversed based on the cold set. In the fuzzy set approach membership values take values in the range (0, 1). For example, a membership level of "0" for a temperature of 14 degrees and a membership value of "0.25" for a temperature of 23 degrees. Contrary to classical clusters, the membership grades of fuzzy clusters can change in infinite number of intervals (0,1). These are a whole bunch of grades of membership that are continuous and unbroken [12]. Binary variables such as cold-warm, fast-slow, light-dark in sharp clusters are likened to the real world by being softened by flexible qualifiers such as a little cold, a little warm, a little darkness in the fuzzy logic.

Definition 1: Fuzzy set; $x = \{x\}$ with x classical cluster with the specified elements express it. Then, the fuzzy set x is A shows a set of modified pairs. $A = \{(x, \mu_A(x)), x \in X\}$, μA is considered to be the membership degree of A, x. It takes a value between 0 and 1. 0 to lowest, 1 to highest membership grade, when $\mu A(x) = 0$, it means that it does not belong to x in. If $\mu A(x) = 1$, it means that it belongs to x in.

Definition 2: Composition of two fuzzy sets; The composition of two fuzzy clusters A and B, (AUB) is the smallest set of clusters covering all elements in A or B or both. Here the composition is expressed by the logical OR operator. Membership functions of AUB are given below. If $a \geq b$ is $\max(a, b) = a$ and if $a < b$ is $\max(a, b) = b$, $\mu_{AUB(x)} = \max(\mu_{A(x)}, \mu_{B(x)})$, $x \in X$ [13].

Definition 3: The intersection of two fuzzy clusters; The intersection of A and B, (AUB) is the widest fuzzy set in A, B, and both. The intersection is expressed by the logical AND operator. If $a \leq b$ is $\min(a, b) = a$ and if $a > b$ is $\min(a, b) = b$ then membership function of AUB is as follows $\mu_{AUB(x)} = \min(\mu_{A(x)}, \mu_{B(x)})$, $x \in X$ [13].

Once fuzzy variables are defined and membership functions are assigned to them. There are some rules that are used in defining fuzzy clusters. In principle, the number of fuzzy sets assigned to each variable is usually a single number. This provides the presence of a center point to prevent numerical oscillation between adjacent values. Second, the number of fuzzy sets is usually between 3 and 9.

To describe causal relations, we must be able to distinguish one subset from the other by the use of linguistic variables. The greater the number of sub-clusters, the more difficult it becomes. It is easy to distinguish between short, medium and long variable values [14].

But with a lot of data, this situation becomes more difficult. The linguistic descriptions of the subclasses can be interpreted. At the same time, each fuzzy set must sum up the compound sets. This overlay provides a continuous control area for the fuzzy controller. Between the compound clusters, it is generally desirable to have 10-50% overgrowth. Once the blur sets have been defined and assigned their membership functions, the rules must be written for each combination of the control variable. These rules will relate input variables to output variables using 'If-Then' expressions in decision-making. The condition 'If' is a prelude to the result of each rule. In general, each rule is shown in 'If' (prefix) 'Then' (result) style [15].

III. IMPLEMENTATION OF RENEWABLE ENERGY RESOURCES WITH FUZZY LOGIC

The primary purpose of our system is to make the most of the sun's rays and wind as much as possible. The better the solar panel takes the sun rays and the better the position of the wind gust wind, the higher the energy production will be. One of the goals is to detect the location of the sun and to set the solar panels to the exact position where they need to be. The other is that the seven wind speed sensors detect the orientation of the wind and bring the wind mood to the exact position required for the horizontal and vertical axes. In our system, according to the fuzzy logic theory, each sensor is able to make the position adjustment control itself of the panels and the wind gauges with the results taken into consideration [1].

Parts in the system; seven light sensors and seven wind speed sensors, stepper motors with solar panel and wind rose for power generation, solar panel and wind rose, PIC control card for fuzzy logic control of the system, LCD displays for system status information retrieval. In addition to the components of this hardware, we have software that is installed in our microcontroller and enables the system to function. The membership grades and values of each sensor are determined according to the information from the sensors. The specified membership values are recorded in the relevant part of the database.

The location information and values are saved in the database where it is separated. These values are constant in each case. Program sections are prepared for each rule. These sections include the conditions set out in the rules. The minimum sensor value determined in each rule section is multiplied by the position constant and stored in the relevant memory area as the rule result value. Rule result values and rule minimum values that are found when all rules are completed are collected separately, and these sum values are stored in the relevant memory area. The total rule value found is divided by the total rule minimum value and the corresponding output port is activated according to the value obtained [2].

Renewable energy system block diagram is shown in Figure 1. The energy system is shown in Figure 2. The system flow diagram is shown in Figure 3. The first step is 'get information from the Sun and wind speed sensors'.

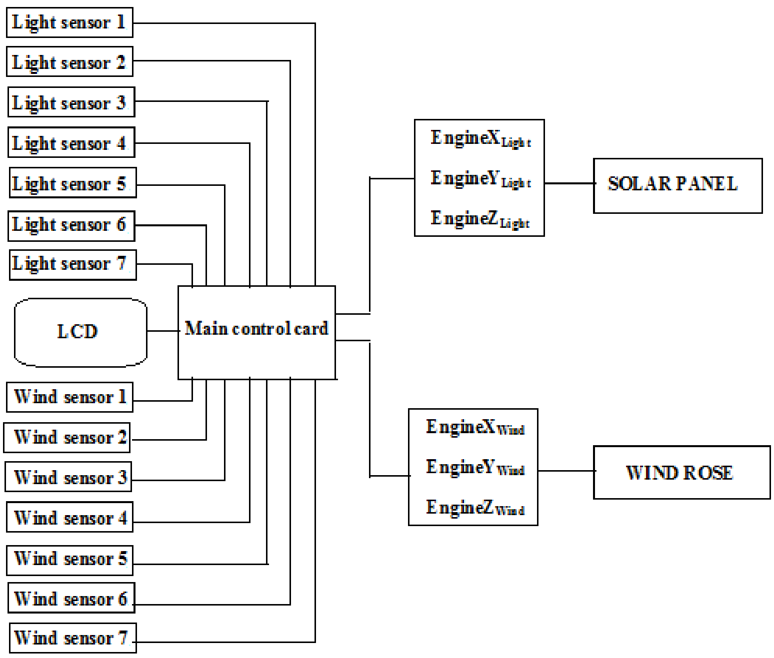

Figure 1. System block diagram

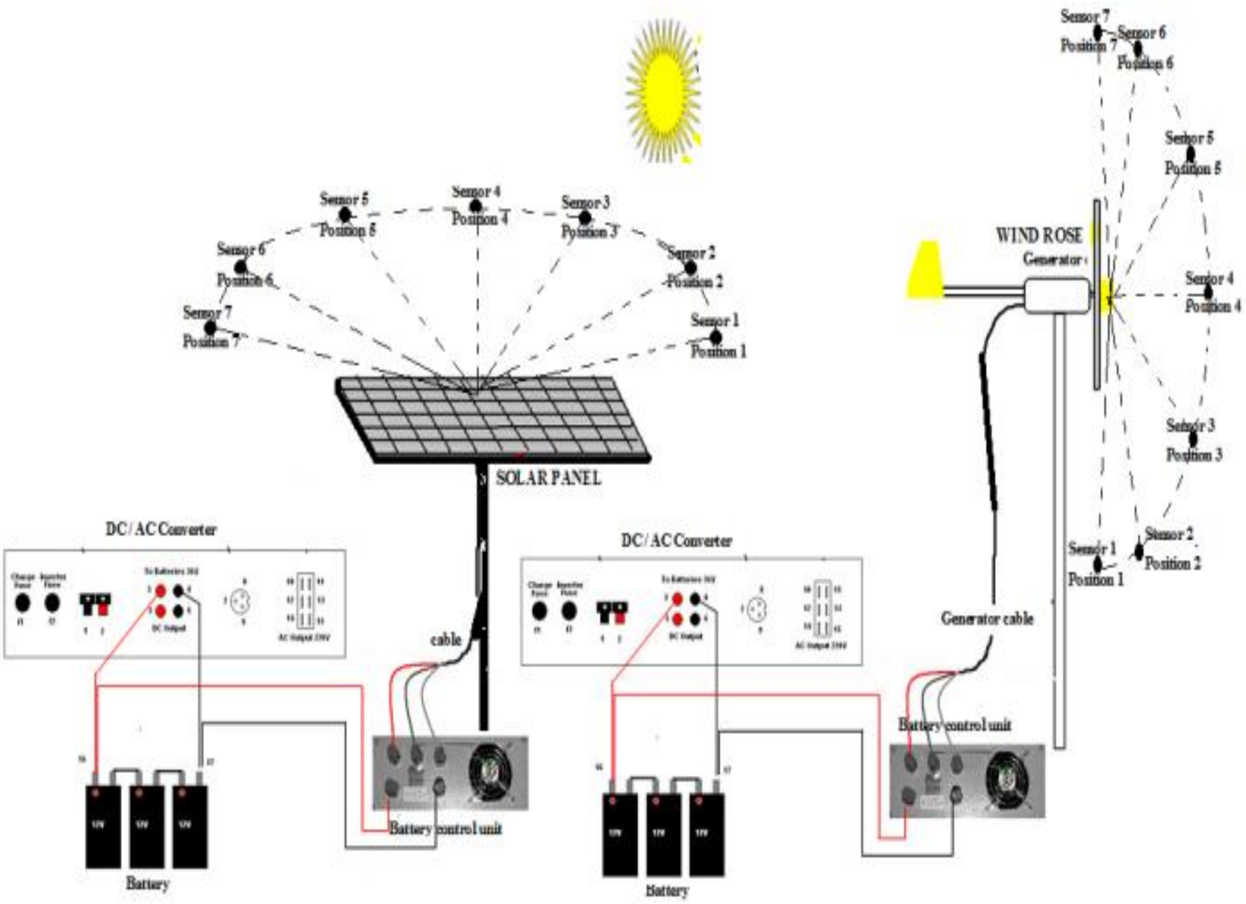

Figure 2. Renewable energy system

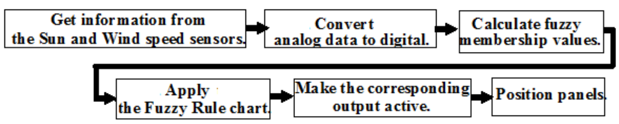

Figure 3. System flow diagram

The second step is 'convert analog data to digital'. The third second step is 'calculate fuzzy membership values'. The fourth step is 'apply the fuzzy rule chart'. The fifth step is 'make the corresponding output active'. As a result, 'bring the panel lies and the windy smile to the desired position' [3].

The boundaries of the membership linguistic values that our sensors in our renewable energy system depend on the strain on them;

L: low value 'when the sensing voltage falls between 0 and 1.5 volts'

N: normal value 'when the sensing voltage falls between 1.5 and 3 volts'

H: high value 'when the sensing voltage falls between 3 and 4.5 volts'

Linguistic position variable symbols;

P1: position 1
P2: position 2
P3: position 3
P4: position 4
P5: position 5
P6: position 6
P7: position 7

Linguistic light sensor symbols;

LS1: light sensor 1
LS2: light sensor 2
LS3: light sensor 3
LS4: light sensor 4
LS5: light sensor 5
LS6: light sensor 6
LS7: light sensor 7

Linguistic wind rose sensor symbols;

WS1: wind rose sensor 1
WS2: wind rose sensor 2
WS3: wind rose sensor 3
WS4: wind rose sensor 4
WS5: wind rose sensor 5
WS6: wind rose sensor 6
WS7: wind rose sensor 7

Table 1. Fuzzy relationship rule table for solar panel

Sensor Input Values							Output
LS1	LS2	LS3	LS4	LS5	LS6	LS7	
L	L	L	L	L	L	L	P1
N	L	L	L	L	L	L	P1
H	L	L	L	L	L	L	P1
L	N	L	L	L	L	L	P2
L	H	L	L	L	L	L	P2
L	L	N	L	L	L	L	P3
L	L	H	L	L	L	L	P3
L	L	L	N	L	L	L	P4
L	L	L	H	L	L	L	P4
L	L	L	L	N	L	L	P5
L	L	L	L	H	L	L	P5
L	L	L	L	L	N	L	P6
L	L	L	L	L	H	L	P6
L	L	L	L	L	L	N	P7
L	L	L	L	L	L	H	P7
…	…	…	…	…	…	…	…

If LS1 is L and LS2 is L and LS3 is L and LS4 is L and LS5 is L and LS6 is L and LS7 is L then Output is P1
If LS1 is N and LS2 is L and LS3 is L and LS4 is L and LS5 is L and LS6 is L and LS7 is L then Output is P1
If LS1 is H and LS2 is L and LS3 is L and LS4 is L and LS5 is L and LS6 is L and LS7 is L then Output is P1
If LS1 is L and LS2 is N and LS3 is L and LS4 is L and LS5 is L and LS6 is L and LS7 is L then Output is P2
If LS1 is L and LS2 is H and LS3 is L and LS4 is L and LS5 is L and LS6 is L and LS7 is L then Output is P2
If LS1 is L and LS2 is L and LS3 is N and LS4 is L and LS5 is L and LS6 is L and LS7 is L then Output is P3
If LS1 is L and LS2 is L and LS3 is H and LS4 is L and LS5 is L and LS6 is L and LS7 is L then Output is P3
If LS1 is L and LS2 is L and LS3 is L and LS4 is N and LS5 is L and LS6 is L and LS7 is L then Output is P4
If LS1 is L and LS2 is L and LS3 is L and LS4 is H and LS5 is L and LS6 is L and LS7 is L then Output is P4
If LS1 is L and LS2 is L and LS3 is L and LS4 is L and LS5 is N and LS6 is L and LS7 is L then Output is P5
If LS1 is L and LS2 is L and LS3 is L and LS4 is L and LS5 is H and LS6 is N and LS7 is L then Output is P6
If LS1 is L and LS2 is L and LS3 is L and LS4 is L and LS5 is L and LS6 is H and LS7 is L then Output is P6
If LS1 is L and LS2 is L and LS3 is L and LS4 is L and LS5 is L and LS6 is L and LS7 is N then Output is P7
If LS1 is L and LS2 is L and LS3 is L and LS4 is L and LS5 is L and LS6 is L and LS7 is H then Output is P7
…………………………………………

Figure 4. Fuzzy software for solar panel

Table 2. Fuzzy relationship rule table for wind rose

Sensor Input Values							Output
WS1	WS2	WS3	WS4	WS5	WS6	WS7	
L	L	L	L	L	L	L	P1
N	L	L	L	L	L	L	P1
H	L	L	L	L	L	L	P1
L	N	L	L	L	L	L	P2
L	H	L	L	L	L	L	P2
L	L	N	L	L	L	L	P3
L	L	H	L	L	L	L	P3
L	L	L	N	L	L	L	P4
L	L	L	H	L	L	L	P4
L	L	L	L	N	L	L	P5
L	L	L	L	H	L	L	P5
L	L	L	L	L	N	L	P6
L	L	L	L	L	H	L	P6
L	L	L	L	L	L	N	P7
L	L	L	L	L	L	H	P7
…	…	…	…	…	…	…	…

The inputs and outputs of our renewable energy system are adjusted and the terms of the linguistic variables are determined, and the audit task is created by creating a set of rules [4]. A total of 343 rules were created when the rule base application was made in the system that we implemented. The rule table of our system is shown in Table 1 for solar panel and Table 1 for wind rose. Fuzzy software for solar panel is shown in Figure 4. Fuzzy software for wind rose is shown in Figure 5.

Renewable power plant created in Silifke-Turkey is shown in Figure 6. Control panel of renewable power plant is shown in Figure 7.

If WS1 is L and WS2 is L and WS3 is L and WS4 is L and WS5 is L and WS6 is L and WS7 is L then Output is P1
If WS1 is N and WS2 is L and WS3 is L and WS4 is L and WS5 is L and WS6 is L and WS7 is L then Output is P1
If WS1 is H and WS2 is L and WS3 is L and WS4 is L and WS5 is L and WS6 is L and WS7 is L then Output is P1
If WS1 is L and WS2 is N and WS3 is L and WS4 is L and WS5 is L and WS6 is L and WS7 is L then Output is P2
If WS1 is L and WS2 is H and WS3 is L and WS4 is L and WS5 is L and WS6 is L and WS7 is L then Output is P2
If WS1 is L and WS2 is L and WS3 is N and WS4 is L and WS5 is L and WS6 is L and WS7 is L then Output is P3
If WS1 is L and WS2 is L and WS3 is H and WS4 is L and WS5 is L and WS6 is L and WS7 is L then Output is P3
If WS1 is L and WS2 is L and WS3 is L and WS4 is N and WS5 is L and WS6 is L and WS7 is L then Output is P4
If WS1 is L and WS2 is L and WS3 is L and WS4 is H and WS5 is L and WS6 is L and WS7 is L then Output is P4
If WS1 is L and WS2 is L and WS3 is L and WS4 is L and WS5 is N and WS6 is L and WS7 is L then Output is P5
If WS1 is L and WS2 is L and WS3 is L and WS4 is L and WS5 is H and WS6 is N and WS7 is L then Output is P6
If WS1 is L and WS2 is L and WS3 is L and WS4 is L and WS5 is L and WS6 is H and WS7 is L then Output is P6
If WS1 is L and WS2 is L and WS3 is L and WS4 is L and WS5 is L and WS6 is L and WS7 is N then Output is P7
If WS1 is L and WS2 is L and WS3 is L and WS4 is L and WS5 is L and WS6 is L and WS7 is H then Output is P7
………………………………………….

Figure 5. Fuzzy software for wind rose

Figure 6. Renewable power plant created in Silifke-Turkey

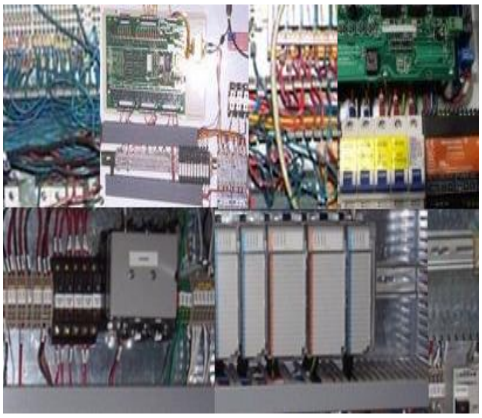

Figure 7. Control Panel

IV. CONCLUSIONS

Solar pillars and wind roses, which are decreasing in production costs, have become an important option as renewable energy in electric energy production. The cost of installation seems to be a little high compared to other systems, but the system is self-depreciating after a while. The most important feature of the solar-wind renewable energy system is that it requires no fuel for electricity generation. Reductions in installation cost and improvements have made solar cells and wind roses an even more effective alternative. In order to be a model for the study, intense sunlight and wind areas were detected in Silifke District-Turkey and an exemplary prototype was constructed by investigating the install ability of the electricity generating power plants from solar energy.

In this study, a position-adjusted system application was introduced for more efficient operation of solar panels and wind roses used to convert solar and wind energy to electrical energy. It is aimed to increase efficiency by positioning panels and wind roses at different sides of the sun and wind. PID controllers that control the elements in the system are used. Seven separate sensors at the system inlet were used to send the panel and wind rose positioning information to the micro controller on the control board and the stepping motors helped to create a solar panel that converts solar energy to electrical energy and more electricity by positioning the wind rose that turns wind energy into electrical energy.

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BIOGRAPHY

Mehmet Zile was born in Ankara, Turkey, 1970. He received the B.Sc. from Yildiz University, Istanbul, Turkey, the M.Sc. degrees from Gazi University, Ankara, Turkey and the Ph.D. degree from Yildiz University, all in Electrical and Electronic Engineering, in 1992, 1999, and 2004, respectively. Currently, he is an Assistant Professor and an academic member of UTIYO, Information Systems and Information Technology Department at Mersin University, Mersin, Turkey. He teaches information systems and control systems. His research interests are in the area of control systems and electrical machines. He is a member of the International Electrical and Electronic Engineers.