Maximum Power Point Tracking PV System Based on Fuzzy Logic Controller

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Abstract: For developing a highly efficient system for tracking maximum power (MPPT) for PV array by the use of fuzzy logic controller technique, this paper is proposed. As power requirements are expanding day by day as we are moving to automation and also the level of pollution is also increasing in order to fulfil these demands of high power. To control the pollution level without compromising with power demands we have to look for renewable energy resources and photovoltaic system is one of that in which no pollution is created in power generation, as sun is a natural source of energy and using PV cell we convert this solar energy into electrical energy without creating any pollution problem. To make this energy conversion more efficient we use mppt technique using fuzzy logic controller(FLC).

Keywords : FLC, MPPT, PV array.

I. INTRODUCTION

Sun is a huge energy source from which the energy comes in the form of heat and light. That energy can be converted into electrical that can be further used for any desired purpose. The device which do this job is called photovoltaic cell in which light energy is converted into electrical but the efficiency of this conversion is a concerning point as till now we are not able to utilise even 50 percent of the energy that fall on a PV cell. There are certain programs and researches are going on in this direction. As it is a renewable energy resource and also in infinite amount it is present in our surroundings. And renewable energy generation is the only option to fight against pollution in the power sector with zero pollution and also without compromising wit the increasing energy demands for the future.

To extract that electrical energy from the solar energy with high efficiency we use this technique of tracking maximum power by the use of fuzzy logic controller which further enhances overall efficiency of system. A controller based on fuzzy logic, used in this paper is designed on the platform of matlab which is highly complex platform that is used many purposes and almost fulfils most of the demands of engineering students through its programming capability and its easy graphical user interface and it also provide all the required functions needed for research in different field. The technology used to extract maximum solar power is generally known as maximum power point tracking. In this we try to collect maximum energy in the given limited area and to make the conversion rate more efficient we use fuzzy logic controller.

II. PV SYSTEM

PV (photovoltaic) system is a set of photovoltaic cells arranged in a specific order also called PV array which is a set of many photovoltaic cells that are combined to make a single integrated system that is used to convert electrical power from solar energy. The PV array used in simulation setup has the characteristics as shown in fig 1.

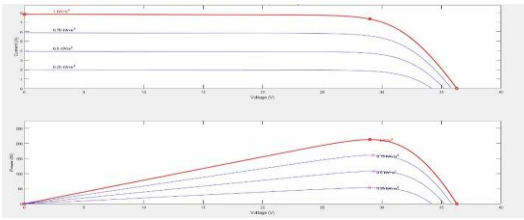

Fig 1: PV array characteristic curve

III. FUZZY LOGIC CONTROLLER

Fuzzy logic is an algorithm in which we give certain inputs and process them based on certain rules and gives the output.

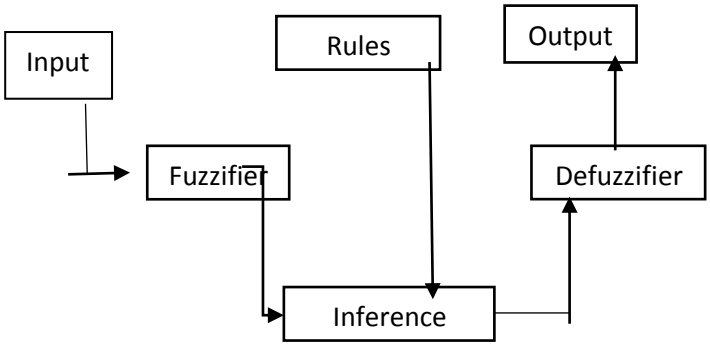

Fig 2: Fuzzy Logic Block Diagram

In fuzzy logic we use certain membership functions that can be input or output membership functions on input membership functions we apply certain rules based on these rules we get the value of output membership functions. Membership functions used in the controller discussed in this paper are as shown in fig4 and fig5.

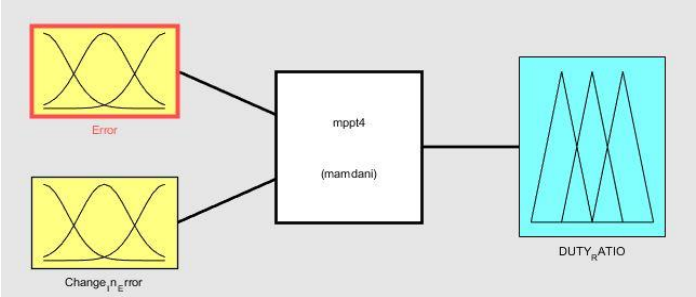

Fig 3: Membership functions plot in FLC

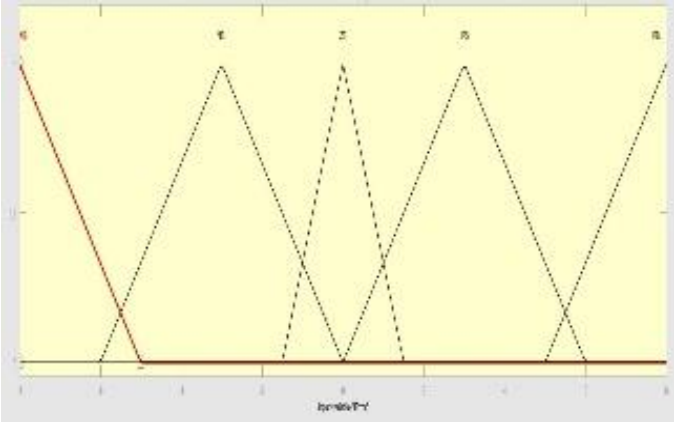

Fig 4: Membership functions in input

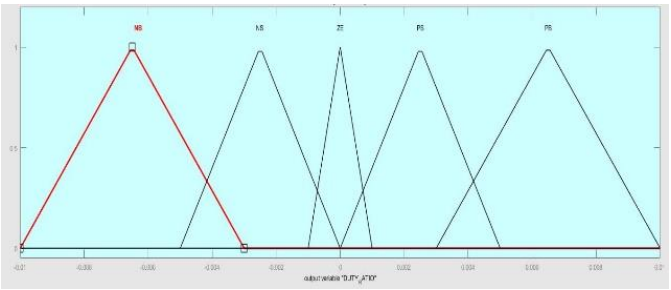

Fig 5: Membership function at output

This fuzzy logic controller contains two input membership fuctions which are error(Err(k)) and change in error(dErr(k)). These functions depend upon power (Pow(k)) and voltage (Vol(k)) of the PV array at k^{th} sample time and shown in equation (1) and (2).

$$Err(k) = \frac{Pow(k) - Pow(k-1)}{Vol(k) - Vol(k-1)} \quad (1)$$

$$dErr(k) = Err(k) - Err(k-1) \quad (2)$$

This fuzzy logic controller based on certain rules that are shown in table 1.

output	Error (E(k))					
Change in error (dE(k))		NegB	NegS	ZE	PosS	PosB
	NegB	PosB	PosB	PosS	PosB	PosB
	NegS	PosB	PosS	PosS	PosS	PosS
	ZE	ZE	ZE	ZE	ZE	ZE
	PosS	NegS	NegS	NegS	NegS	NegB
	PosB	NegB	NegB	NegS	NegB	NegB

Table 1: fuzzy set rules

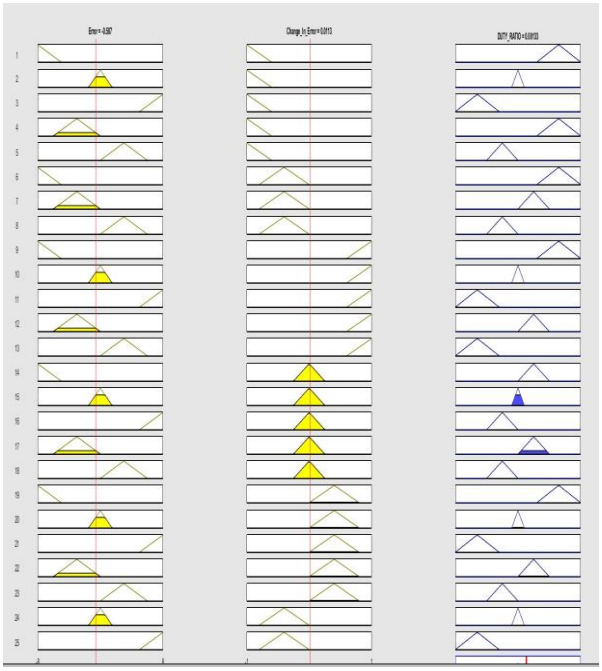

Fig 6: Rule viewer of FIS

IV. SIMULINK SIMULATION SETUP

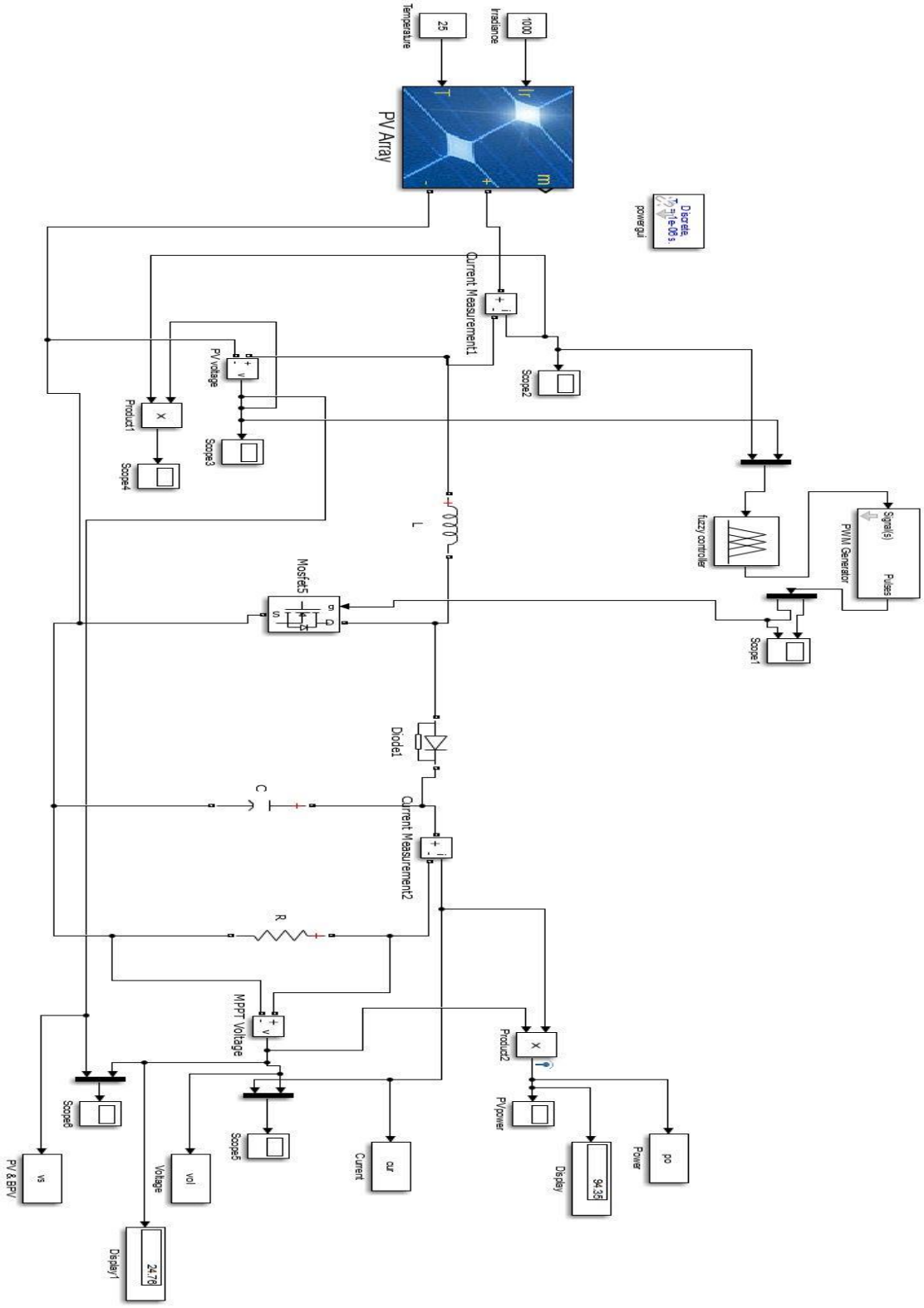

Fig 7: Simulation setup for Simulink

V. SIMULATION RESULTS AND DISCUSSION

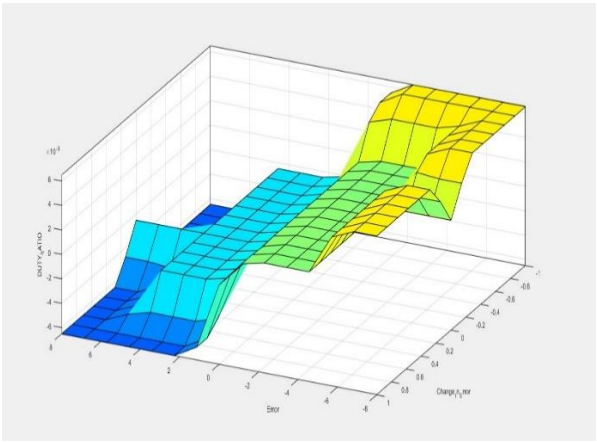

Fig 8: Overview of surface viewer of FLC

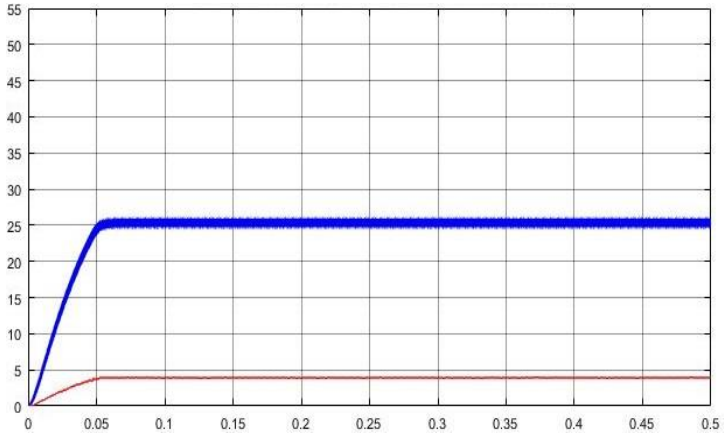

Fig 9: Output Voltage and Current Graph

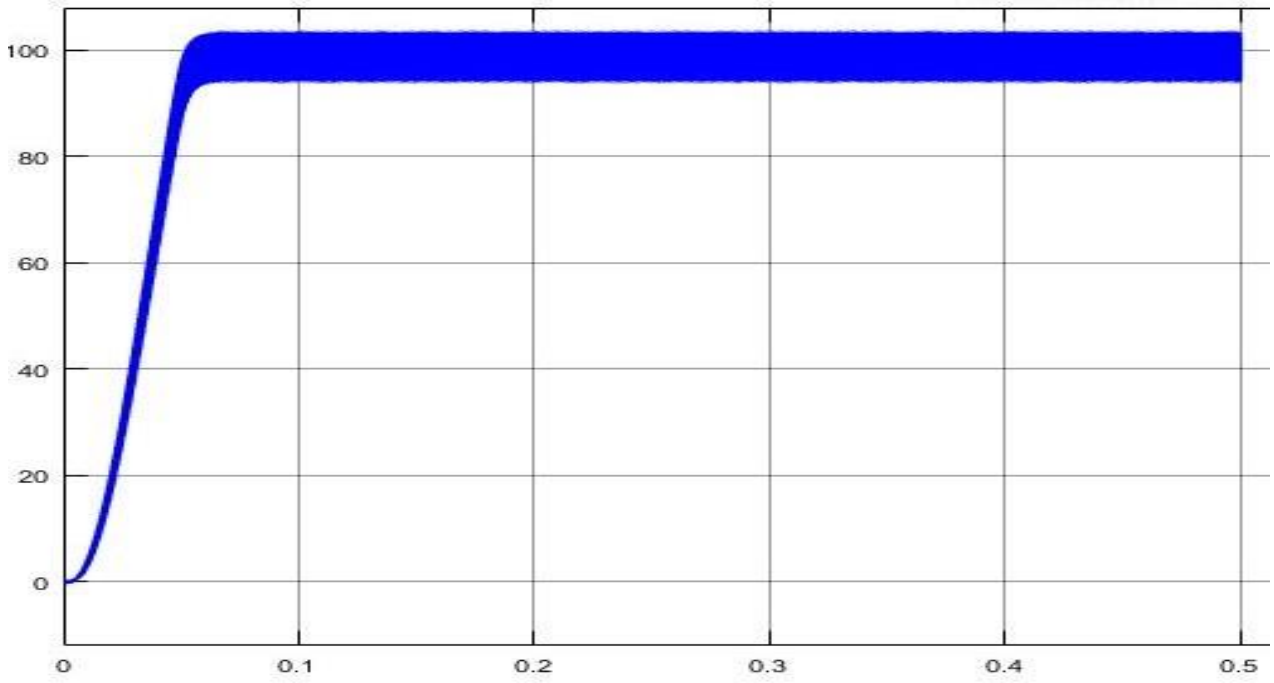

Fig 10: Output Power graph

The duty ratio (i.e. the output membership function of FLC) changes according to membership functions at input i.e. error(Err(k)) and change in error(dErr(k)) and from the surface viewer of FLC in fig 8 we can see the direct relationship among all the three membership functions.

Inputs given to PV array are irradiance and temperature and output voltage and power of PV array is given to FLC which will decide the level of voltage and current at which we get the maximum power output from PV array and that will result into a highly efficient MPPT system. In fig 9 the values of output current and voltage is shown for which output power will be maximum which is shown in fig 10. At output voltage about 25-26 volt and output current about 4-5 ampere, we gets the maximum output power of about 100-

110 watts, which indicates that the efficiency of used PV array is about 47-48 percent.

VI. CONCLUSION

In this paper we proposed a system of tracking maximum power which is by using the controller which is based on fuzzy logic algorithm, and using this setup we can see that we get the efficiency PV array about 47-48 percent which reasonably very good. As future generation is going to use renewable energy resources, so the scope in the field of solar cells is going to be very good and the advancement in the design and efficiency of solar cells is going to be increased year by year with the advancement of new technologies. As the energy coming from sun is infinite but the conversion and utilisation of that energy with a high efficiency will be a challenge for the upcoming generations as till now we haven't reached upto the efficiency of 50 percent in solar energy field, so it's going to be huge challenge in the near future to fulfil all energy demands from renewable energy resources alongwith saving environment from pollution.

VII. REFERENCES

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