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RBFNN Machine Learning BASED BLDC Motor Driven PVFed Electric Vehicle

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Abstract:

This paper presents a Radial Basis Function Neural Network (RBFNN) based MPPT(Maximum Power Point Tracking) algorithm. This algorithm is implemented in Sensor less Permanent magnet Brushless DC Motor for driving an electric vehicle. In order to enhance the voltage level of the PV(Photo voltaic) cell, the Continuous Input and Output(CIO) boost converter is used and it has the excellent voltage-gain ratio with continuous power for tracking the maximum power. The BLDC motor speed is controlled by the implementation of PI controller to drive the EV vehicle. Developments are also made in increasing the applicability in various other fields like electric vehicles, motor drives, power quality improvements and various high-power applications. The simulation results are verified using the hardware circuit using DSPIC30F4011controller

Keywords **—RBFNN, MPPT, PV, Continuous Input and Output(CIO) Converter, EV.**

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I. INTRODUCTION

Fossil fuels are the main source of energy for the power generation and transportation industry. But in recent years, climate change has increased global awareness of the negative effects of fossil fuel use. The electric car charging space has grown over the past decade. Wireless charging of electric vehicles is very useful as it prevents disassembly and reduces safety risks. The principle of dynamic wireless charging technology for electric vehicles is to shorten the wireless charging time of electric vehicles and improve the power and efficiency of wireless charging equipment, which is not only to increase power charging, but also to reduce power charging.

Increase the operating frequency, thus reducing power loss during wireless communication.

Governments and businesses are switching to clean energy and reducing environmental pollution. In this case, it would involve using electric vehicles (EVs) to use electricity for transportation and renewable energy to generate electricity. Electric vehicles replace gasoline as a clean mode of transportation with low carbon emissions and low energy consumption. As technology and batteries evolve, millions of electric vehicles will be used for integration into the transportation and electric power system.

However, the lack of sufficient charging is the biggest obstacle to the spread of electric vehicles. The popularity of electric vehicles and electrical distribution equipment has brought some problems in the distribution network. Therefore, there is a growing need to plan to charge electric vehicles appropriately and to create new conditions for the use of electricity.

Advances in battery technology, growth in the automotive industry, grid automation etc. increasing the prevalence of electric vehicles and facilitating the long-term transition to better transport. For example, the cost of battery storage, which accounts for 25 percent of electric vehicle costs, is expected to fall from $1,000 per kilowatt-hour in 2007 to $200 in 2021.

There are more electric cars than there were five years ago. It can now be seen on the streets around the world. New electric vehicle registrations increased by 70% between 2014 and 2015. Electric vehicles are expected to make up the majority of transportation in the next 20 years.

Electric Vehicle (EVI) is an electricity-based policy and the number of electric vehicles will reach 20 million by 2020.

According to the Electric Vehicle Institute, 62 percent of vehicles in the United States will be replaced by PEVs by 2050. Store batteries to power their engines. The architecture of charging station using DC bus is shown in Fig 1. Electric cars come in many models with different types, sizes and features.

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Generally, EVs use 170-230 Wh/km. Most electric cars plug into a power outlet to charge.

The number of EV models available and EVs on the road is growing rapidly due to the need for charging stations. While the number of public charging stations is currently limited, public and private funding for charging stations is growing rapidly.

Currently, the most important problem for electricity generation is electricity use, due to climate change and rising fossil fuel prices.

Currently, a large part of fuel consumption is distributed in transport and a large part in transport. According to the "International Energy Outlook" report, the share of the transportation sector in the world's total energy consumption will reach 55% by 2030. Electronic vehicle control requires the support of communication standards. In some cases, data is sent from grid operators to EVs; bidirectional unicast is sometimes required to control the behavior of certain EVs; and finally, the competition of EVs for charging stations and response stations should be done in a special way.

Many companies around the world are working to develop different batteries for electric and hybrid vehicles.

However, the performance of the battery module depends on the design and how the module is discharged and charged. In this sense, battery chargers play an important role in the development of this technology. Many types of electric vehicles such as battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV) in different configurations and fuel electric vehicles (FCEV) are currently being developed as alternatives to internal combustion engine (ICE) vehicles.

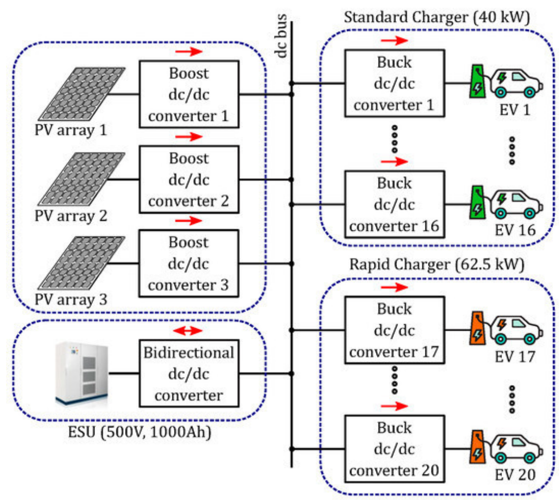

Fig.1.Charging stations architecture using DC bus

II. EXISTING SYSTEM

The most important problem of today's climate change and increasing fossil fuel prices is electricity consumption. Currently, a large part of the use of fuel is distributed in transport, and a large part is distributed in transport. According to the "International Energy Outlook" report, the share of the transportation sector in the world's total energy consumption will reach 55% by 2030.

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Countries like India have an increasing need for electricity due to population growth and rapid economic growth. Increasing demand for electricity and the scarcity of energy resources in the country is going to reduce the gap between energy supply and demand. Renewable energy (RE) is the opposite, to close this energy gap without using a lot of energy. Among all renewable energy sources, solar energy is the most beneficial source of electricity due to its abundance, low cost and environmental friendliness. Agriculture in India uses most of its electricity for irrigation.Therefore, solar energy is the most important renewable energy source used to run generators in water systems. Solar photovoltaic (PV) based water systems include photovoltaic panels, high efficiency motor pump units, inverter modules and battery storage. The solar PV driven irrigation pump has many advantages because it increases reliability with lower operating and maintenance costs. Motor drives that come directly from photovoltaic arrays have problems working well under a variety of conditions. Considering all the consequences in the state for the photovoltaic generation junction, solar power generation and water use should be done.In two-phase topology, the DC-DC converter is used for maximum power point tracking (MPPT) control to extract maximum power from the PV array, while the DC bus is usually controlled from a three-phase voltage source inverter (VSI). .). Unlike single-phase solar PV systems, this two-phase model keeps the DC bus voltage at a constant value with better response regardless of solar radiation. In recent years, many MPPT methods have been reported to extract maximum power from solar photovoltaic arrays via DC-DC power conversion. Unlike incremental conductivity (INC) and perturbation and observation (P&O) algorithms, they are the most popular and commercial MPPT methods due to their simplicity and generality. However, the performance of this technique depends on the size of the trace; the larger the step size, the faster the response, but the larger the selected step size, the oscillations will occur regularly.Additionally, solar power systems using standard P&O systems oscillate around maximum power even under constant or slowly varying radiation. Also, when sudden changes occur, P&O-based schematics can be confused with changes in direction, leading to distortions. Similarly, the INC method cannot effectively monitor the MPP of the PV array because the slope is too low during rapid change. Therefore, to solve these problems in traditional P&O and INC methods, many proposed search algorithms have been interpreted recently, such as modified P&O, improved P&O, and improved INC. Similarly, we developed a P&O algorithm that provides better tracking than standard P&O.A The neural network is a powerful tool for controlling the speed of many different variables. An estimation method based on model usage correction (MRAS) is more useful than the above method because of its ease of use. Various MRAS-based schemes have been reported in the literature, i.e. As rotor flux, as back electromotive force, as active power, as power current, as stator current and back electromotive force, etc. Here is a modified MRAS based on immediate use. There is a large literature on acceleration estimation with current electronic method to minimize the error problem in transient response. The novelty of this article is summarized as follows: 1) A new analytical MPPT control (AMPPTC) technique with improved monitoring is applied to the IMD-based solar photovoltaic water pumping system. 2) AMPPTC exhibits high performance sensing and high speed operation during dynamic changes. The battery is used as backup power for the solar system. 4) Hybrid photovoltaic-battery water pump system can work in single operation and battery connection operation. Due to rapid population and economic growth, countries like India have increased their electricity demand. The demand for electricity is increasing and the decreasing electricity supply makes it possible for the country to reduce the gap between electricity supply and demand. In this current system, a method has been devised to achieve maximum power point tracking (MPPT) for a solar photovoltaic (PV) array based on driving vehicle induction (IMD) along with water use. The gate signal is designed using the Space Vector Pulse-Width Modulation (SVPWM) method of a three-phase inverter. This experimental MPPT control (AMPPTC) scheme offers the fastest and cheapest operation in IMD-based water applications. The first stage uses a boost DC-DC converter operating at the MPP to convert the PV array voltage to a higher DC-link voltage using a monitoring-less measurement method.

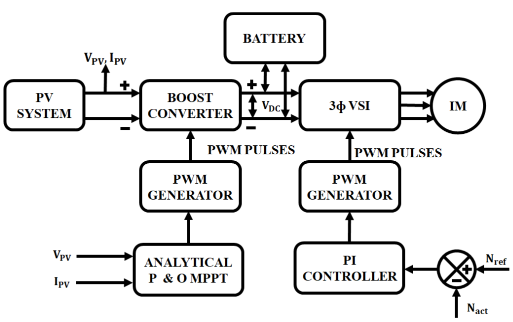

Fig.2. Block Diagram of Existing System

The second stage converts the high DC voltage to a three-phase AC voltage fed to the IMD, which uses a three-phase VSI process with a Space Vector Pulse-Width Modulation (SVPWM) scheme to optimize the use of the DC bus voltage. 4 444 2. MPPT Efficiency Block Diagram of Existing System 2.Figure 2 shows a 55 kW solar PV array used with an analytical monitoring system for a 2.2 kW (3 hp) IM-connected water pump. The tracking performance of this MPPT method has been tested at different insolation intensity levels (1000 and 500 W/m2). Monitoring performance for both levels is almost 100%. Measure the response of the photovoltaic cell system. The tracking performance in this case was found to be poor compared to the MPPT recommendation (especially in low sunlight). Tracking performance is further improved when MPPT is performed at two insolation levels by the non-P&O MPPT algorithm. MPPT performs worst when the system is running with the P&O algorithm that controls the MPPT. Therefore, the AMPPTC method is the best method to reach the MPP of photovoltaic arrays in different solar insulation systems, which shows the efficiency and power of its behaviour is not good.

III. PROPOSED SYSTEM

The block diagram of the proposed body is shown in fig 3. In the proposal, the solar photovoltaic system is integrated with a backup battery to provide the BLDC motor for electric car use. The output of photovoltaic systems is interactive in nature, so high-income consumers need to increase their output. In this mode, the RBFNN MPPT converter uses the MPPT algorithm and gets the maximum power from the PV system. The proposed RBFNN MPPT method generates pulses to control the output of the proposed converter.

During the day, photovoltaic generate enough electricity to power an electric car's BLDC motor. But at night, when photovoltaic power is not available, battery power is used as backup power to run the BLDC motor.

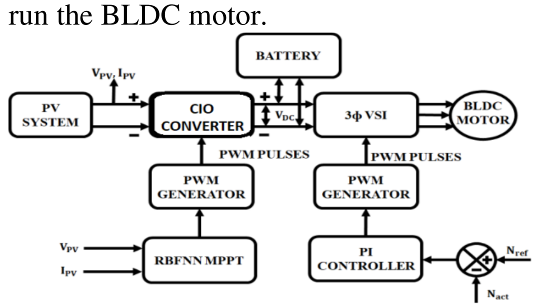

Fig.3. Block Diagram of Proposed System

The input converter output is fed to the three phase VSI and the resulting VSI output is used for the BLDC motor.
Here, the actual speed and reference speed are compared to control the speed of the BLDC motor and the error is applied to the PI controller. Speed control of BLDC motor driver is achieved by PI control technology, which reduces torque ripple and ensures no noise. Determine the counter-electromotive force, generate the corresponding pulses and feed them to the VSI switch to realize constant speed control.

IV. RBFNN ALGORITHM

A RBFNN is an artificial neural network that uses radial basis functions as activation functions as shown in Fig 4. RBF network in its simplest form is a three-layer feed forward neural network. The first layer corresponds to the inputs of the network, the second is a hidden layer consisting of a number of RBF non-linear activation units, and the last one corresponds to the final output of the network. Activation functions in RBFNs are conventionally implemented as Gaussian functions.

$$f(x) = \sum_{j=1}^{m} w_j h_j(x)$$

$$h_j(x) = \exp(-(x-c_j)^2 / r_j^2)$$

Where cj is center of region
rj is width of the receptive field

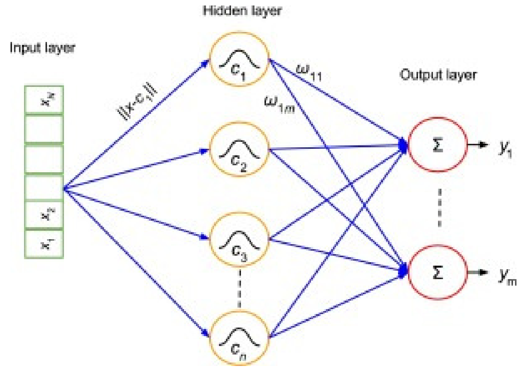

Fig.4. RBFNN Algorithm

RBFNN have 5 parameters for optimization:

1- The weights between the hidden layer and the output layer.
2- The activation function.
3- The center of activation functions.
4- The distribution of center of activation functions.
5- The number of hidden neurons.

The weighted average of the hidden and open layers is calculated using the Moore-Penrose generalized pseudo-inverse. This algorithm overcomes many of the problems in standard gradient algorithms, such as the constraints, training cost, number of times, and local minimums. Due to its short learning time and wide-ranging capabilities, it is worth the real-time investment. For pattern recognition applications, the preferred radial basis function is usually the Gaussian kernel. In general, the mean and distribution of the activation function should have similar properties to the data.
Here, the Gaussian mean and width are chosen using the Kmeans clustering algorithm. According to the general estimate, if the number of hidden neurons is large enough, the center and distribution of the activation function is uncertain. to all the right levels.

V. SIMULATION RESULTS

Now that our model is built, we are ready to simulate the system. To do this, go to the Simulation menu and click Start or click the

"Start/Pause Simulation" button (like the "Play" button) on the model window toolbar.

Since our example is a simple model, its simulation is almost instantaneous. For most systems, however, you will be able to see the progress of the simulation by looking at the elapsed time in the box at the bottom of the model window. Double-click the block to see the output of the analog gain block over time. The simulation diagram of the proposed process using the RBFNN algorithm is shown in Fig 5. The design of the CIO boost converter is given below and the simulation diagram of the converter circuit and solar system is shown in Fig 6.

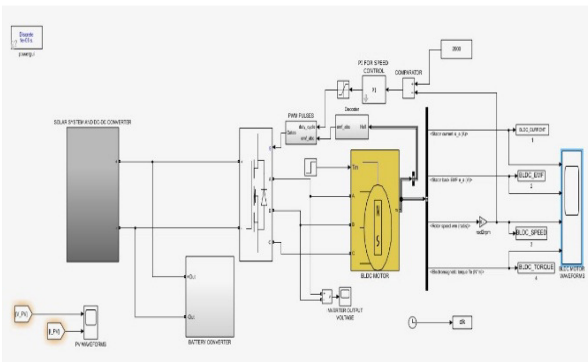

Fig.5. Simulink Diagram of Proposed System

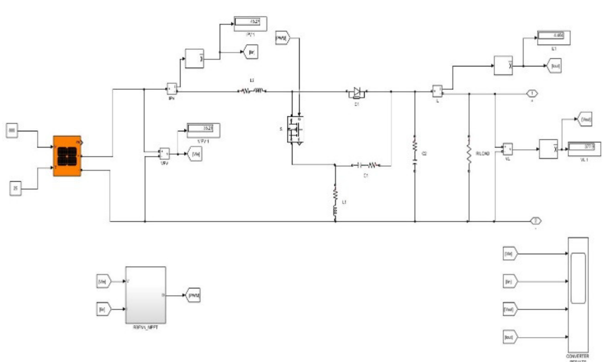

Fig.6. Simulink Diagram of Solar System With CIO boost converter

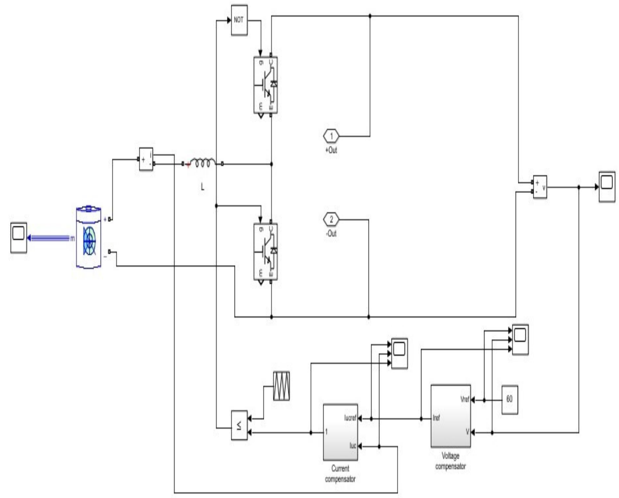

Fig.7. Simulink diagram of battery converter

Design parameters of the Converter circuit:

C_1=(22)*(e^6)F,R_L=100ohms , L_1=(1)*(e^-3) H
C_1 internal resistance=0.005 ohms
L_1 internal resistance= 0.0001 ohms
C_2=(22)*(e^6), L_2=(1)*(e^-3)H
, internal resistance=0.005ohms,L_2 internal resistance= 0.0001 ohms.

The analog input voltage and input current for the converter are shown in figure 8. As seen in Figure 9, the input voltage of the converter is 40V and the output voltage of the converter is 400V. The output power of the converter is the energy stored in the battery as shown in figure 10. The energy stored in the battery is converted into an AC signal as shown in fig 11.

The inverter drives the motor of the electric car, and the simulation waveforms of the motor current, back electromotive force, motor speed and torque are shown in Fig11 and Fig 12

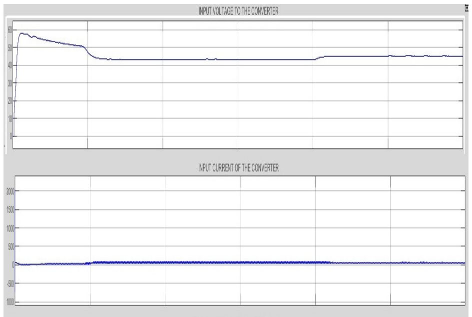

Fig.8. Simulation waveform for input voltage and current

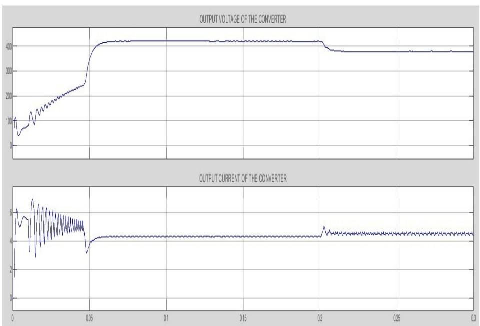

Fig.9. Simulation waveform for output voltage and current

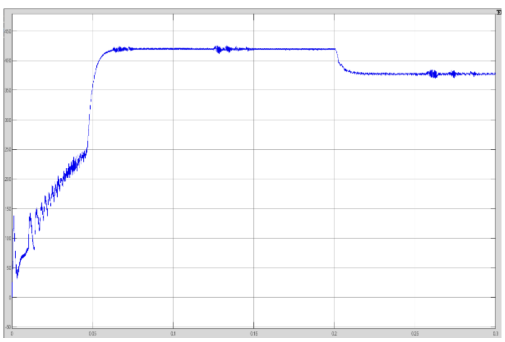

Fig.10. Simulation waveform for battery output voltage

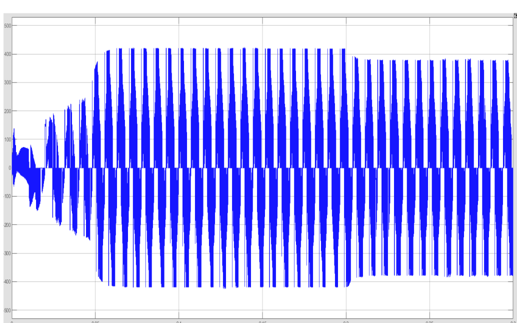

Fig.11. Simulation waveform for inverter outputvoltage

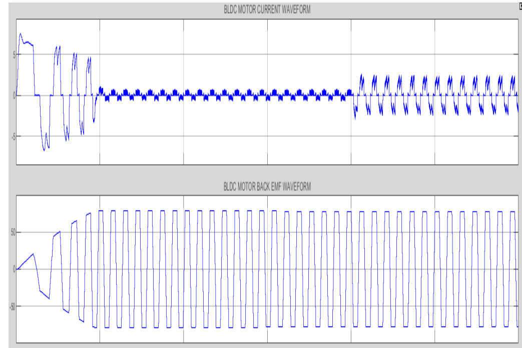

Fig.12. Simulation waveform for motor current and back EMF

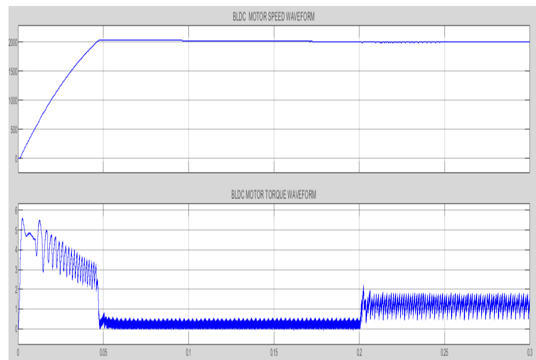

Fig.13. Simulation waveform for Motor Speed and Torque

VI. Conclusion

This project focuses on the design of a BLDC moto r photovoltaic cell with backup battery suitable for electric vehicles.By integrating battery management into the plan, uninterrupted power can be provided for BLDC operation. RBFNN based on MPPT is us ed to extract the maximum power from the solar ph otovoltaic system and then puts the output as a PW M signal from the PWM generator to convert it in t he Luo converter. Also this process uses a PI contro ller to keep the speed of the BLDC motor running s moothly. MATLABbased simulation results evaluate the feasibility of developing a photovoltaic -based EV system.

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