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Wireless Power Harvesting and Switching Network for Smart Power Utilization

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Abstract— **We present a wireless power harvesting system for smart utilization without any wastage. The design consists of various switching networks which used by the generated power through the wireless coils. The load circuits are connected with the switching networks and thus the energy log is maintained. Based on the energy log, the analysis is done using Deep learning neural network and the future demands are met. Thus the prototype is developed and simulated accordingly. The proposed system is simple and hence can be used for wireless power transmission and reception.**

Keyword – wireless, power, harvesting, switching, power distribution, utilization, deep neural network.

I. INTRODUCTION

Unless we are organized and good with tie wrap, we probably have a few dusty power cord tangles around our home. We may even had to follow one particular cord through the seemingly impossible snarl to the outlet hoping that the plug we pull is the right one. This is one of the drawbacks of electricity. While it make people's lives easier, it also adds a lot of scramble in the process. For such reasons, scientists tried to develop methods of wireless power transmission that could cut the scramble or lead to clear sources of electricity. Researchers have developed several techniques for transmitting electricity over long distances without wires. This paper provides the techniques used for wireless power transmission and smart distribution. These techniques are classified into three types based on the distance between the transmitter and receiver. They are: Short range, Moderate range and Long range. Short distance induction: This method can reach at most a few centimeters. The action of an electrical transformer is the simplest instance of wireless transfer of energy. The primary and secondary circuits of a transformer are isolated electrically. The transfer of energy takes place by electromagnetic coupling through a process called as mutual induction.

II. RESONANCE OF WIRELESS POWER

Household devices produce very small magnetic fields. For such reason, chargers hold devices at a distance close together to induce current. A larger and stronger field could induce current from farther distance, but the process would be inefficient. Since magnetic field spreads in all directions, a larger field may waste a lot of energy. An efficient way of transfering power between coils separated by a few meters is by increasing the distance between the coils and adding resonance to the equation. The better way to understand resonance is to think of it in terms of sound. An object's physical structure determines the frequency at which it naturally vibrates. This is its resonant frequency. The objects can be made to vibrate at their resonant frequency and difficult to get them vibrate at other frequencies. Induction can take place differently, if the electromagnetic fields resonate at the same frequency around the coils. The curved coil of wire is used as an inductor. A capacitance plate, which holds a charge, attaches to the each end of the coil. As electricity travels through this coil, it begins to resonate. The resonant frequency is the product of the inductance and the capacitance of the coil and plates respectively. The wireless power transmission uses a curved coil and capacitive plates.

III. LONG DISTANCE WIRELSS POWER

The induction sends power over short distance even if the resonance is not incorporated. But some plans of the wireless power involve moving electricity over a span of distance. In the early 1980, Canada's Communications Research Centre has created a small airplane that could run off the power beamed from the Earth. The unmanned plane called the Stationary High Altitude Relay Platform (SHARP), as designed as a communication relay. Rather than flying from point to point, the plane could fly in circles with two kilometers in diameter at an altitude of about 13 miles (21 kilometers). Most importantly, the plane could fly for months at once. The secret behind the SHARP's long flight time was a large ground-based microwave transmitter. The SHARP's circular flight path kept it in the range of this transmitter. A large disc-shaped **rectifying antennae**, is placed just behind the plane's wings which changes the microwave energy from the transmitter into direct-current (DC). Because of the microwave interactions with the rectifying antenna, the SHARP had a constant power supply when it was in range of a functioning microwave array. Rectifying antennae are central to many wireless power transmission projects.

IV. DESIGN METHODOLOGY

The wireless power transmission can be defined as the process in which energy can be transmitted from the transmitter to a receiver through an oscillating magnetic field. To attain this, DC(Direct current) is changed into high frequency AC (Alternating Current) by particularly designed electronics in the transmitter. The AC boosts a copper wire coil in the transmitter, thus it produces a magnetic field. When the receiver coil is placed in proximity of the magnetic field, it can make an AC (alternating current) in the receiving coil. Electronics in the receiving coil then alters the AC back into DC which then becomes operating power.

Wireless Power Transmission Coils:

Based on the size and shape of the transmitting and receiving coils, the magnetic fields are analyzed. The magnetic field is evaluated in the gap between the transmitting and receiving coils and the induced current. Also the voltage in receiving coil are evaluated. The computer simulations are performed using the Finite Element Method (FEM).

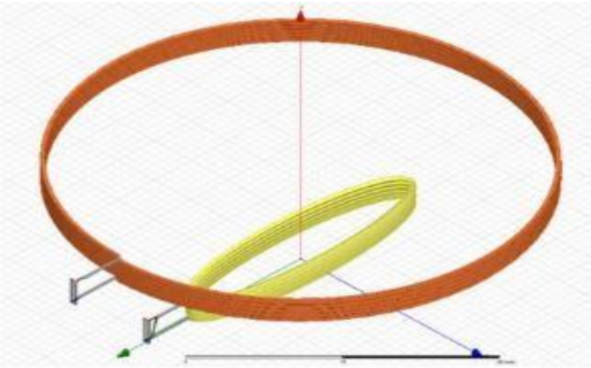

Fig 1. Wireless Power Transmission coils (WPT COILS).

Solar Panel:

Solar panel refers to a panel designed to absorb the sun's rays as a source of energy for generating electricity or heating. Solar panels constitute the solar array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions. Solar modules use light energy from the sun to generate 5W power through the photovoltaic effect. Efficiencies of solar panel can be calculated by MPP (Maximum power point) value of solar panels. It is a capacity of the solar panel and the higher value can make higher MPP. These panels are designed for the most rugged off-grid applications.

Fig 2. Solar Panel

PIC Microcontroller (PIC 16F877A):

The 16F877A is a capable microcontroller that can do many tasks because it has a large enough programming memory (large in terms of sensor and control projects) 8k words and 368 Bytes of RAM. This is enough to do many different projects. The 40 pins make it easier to use the peripherals as the functions are spread out over the pins. This makes it easier to decide what external devices to attach without worrying too much if there are enough pins to do the job. One of the main advantages is that each pin is only shared between two or three functions so its easier to decide what the pin function.

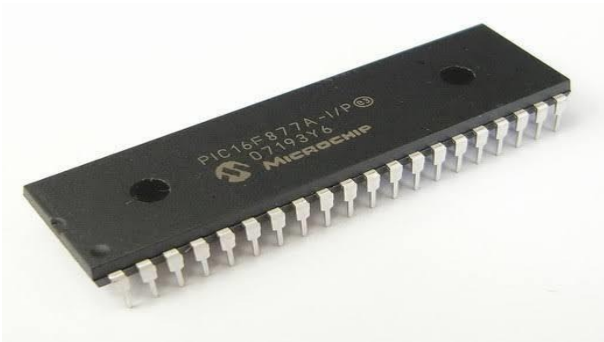

Fig 3. PIC 16F877A

Four Relay Board:

Relays are simple switches which are operated both electrically and mechanically. Relays consist of a n electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet. The main operation of a relay comes in places where only a low-power signal can be used to control a circuit. It is also used in places where only one signal can be used to control a lot of circuits. They were used to switch the signal coming from one source to another destination. The high end applications of relays require high power to be driven by electric motors and so on. Such relays are called contactors.

Fig 4. Four Relay Board

Software Analysis:

Nowadays there are many examples of complex systems at macroscopic scale level: the climate system, a number of ecosystems, the global economic system, internet, etc. In this framework, as we will see, modeling a complex system (or the relationships between this system and its external environment) by artificial neural networks (ANNs), gives the possibility of fully taking the nonlinearities into account, even without considering the number of closed loops present in the system itself and their complex interactions. At present, ANNs are developed and used in many fields of the scientific research, with various different purposes. Here, we apply a basic kind of ANNs the feed forward networks with back propagation training which is able to perform realistic nonlinear multiple regressions in a reliable manner, if applied correctly. Anyways, all these considerations will appear clearly when ANNs will be formally introduced and then applied to concrete case studies. The Data-driven models and the artificial intelligence methods have been considered as the fundamental tool for achieving knowledge in a big-data environment.

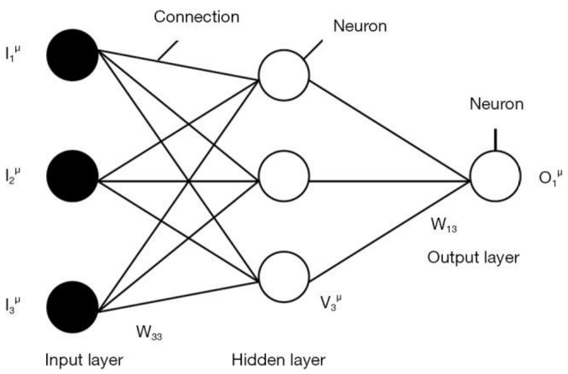

Fig 5. Artificial Neural Network

The fundamental elements of the neural network are the connections, with their associated weights (w_{jk} and W_{ij}), and the neurons of the hidden and the output layers, which represent the single computational units. In this architecture of the neural network each neuron is connected to all the other neurons of the previous and the following layer and also there are no connections between the neurons on the same layer. Let us consider the inputs as some causes which drive the output (our effect), it is clear that our aim is to find a transfer function that correctly leads us to the correct output (the so-called "target"). As a fact, once the weights are fixed, the nonlinear functions g_j calculated by the hidden neurons and the linear function f_i is calculated at the output neuron, this network is able to do so. In fact, in the general case of multiple outputs, the i-th output is given by:

$O_{\mu i}=f_i(\sum_i W_{ij}V_{\mu j})=f_i[\sum_j W_{ij}g_j(\sum_k w_{jk}I_{\mu k})]$

[1]

Where:

$I_{\mu k}$ = inputs (usually normalized between 0 and 1, or -1 and 1);
w_{jk} = the connection weights between input and hidden layers;
W_{ij} = connection weights between hidden and output layers;
$V_{\mu j}$ = output of the hidden neuron N_j = input element at the output neuron N_i;
•$g_j(h_{\mu j})=1/[1+\exp(-\beta h_{\mu j})]$ (for inputs normalized between 0 and 1) or $g_j(h_{\mu j})=\tanh(\beta 2/)$ (for inputs normalized between -1 and 1), with the steepest parameter β which is often set to 1;
•$f_i(h_{\mu i})=h_{\mu i}$;
•$h_{\mu i}$ and $h_{\mu j}$ are weighted sums implicitly defined in
As cited above, is written for the general case of multiple outputs. In our case of a single output i=1.

As evident from the output depends critically on the values of the weights w_{jk} and W_{ij}, exactly as in a multiple linear regression the value of the dependent variable y depends on the values of coefficients associated to the linear terms of the independent variables x, z, t, etc. Thus one tries to minimize the following squared cost function $E_\mu=12\sum_i(T_{\mu i}-O_{\mu i})2$ for every input-target pair (pattern) μ, where (the targets) represent our observational data of a certain variable which summarizes the real behavior of the system under study, and are the results of our ANN model. While this minimization activity is insignificant for linear regressions, in our multiple nonlinear cases it is a risky one. Several methods have been developed for approaching this problem. Here, I briefly describe an iterative procedure, the so-called error back propagation training.

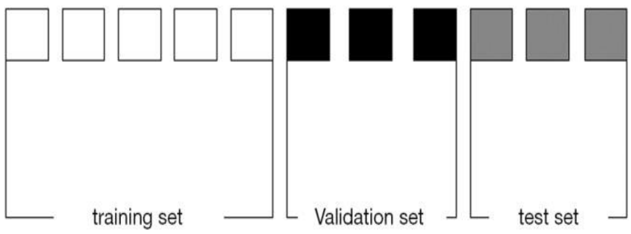

Fig 6. A set of data is divided into three subsets

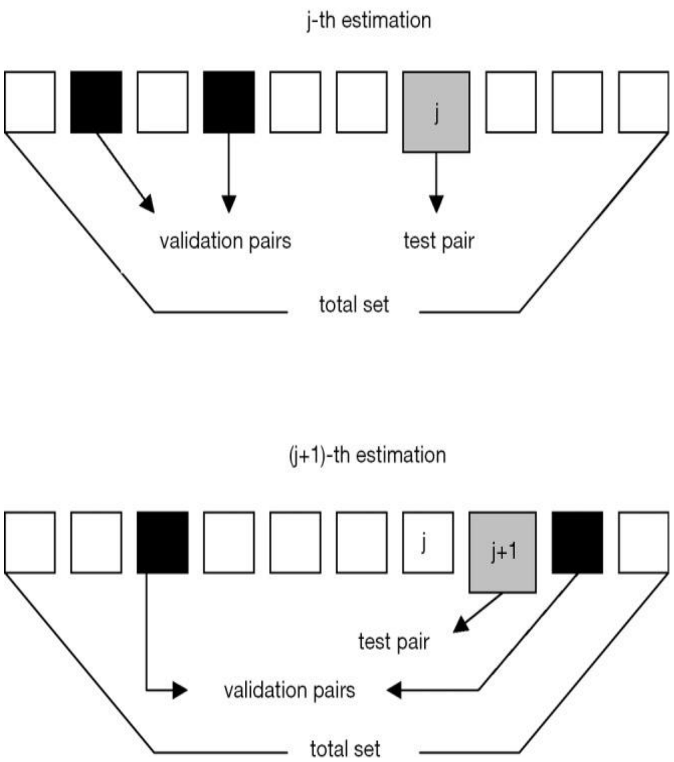

Fig 7. Generalized Leave-One-out model

PROPOSED DESIGN:

In the proposed design, the transmitter side has the solar panel from which the energy is collected and passed to the power converting circuits. In rectification process, the Alternating current is converted into Direct current from which the power is transmitted through wireless transmitter. The wireless transmitter and receiver are made up of copper coils. The receiver side has the power collected and is sent to the voltage measurement. The configurable load circuits are designed in which the energy log is maintained to analyze the future demands. Deep neural network is used to analyze the various applications and amount of power consumption of the Input energy data. In simple terms, the system proposed is based on the concept of Demand based efficient Power Allocation System (DPAS).

The important application of this concept is Smart Energy management and Smart Energy Consumption. Since the load circuits are configured, by switching circuits the power can be transferred and shared between the devices. The overall analysis is done and the data log is maintained in the cloud. Those data can be referred for the further details.

The detailed outline of the design and proposed system is shown in the following block diagram.

Block Diagram:

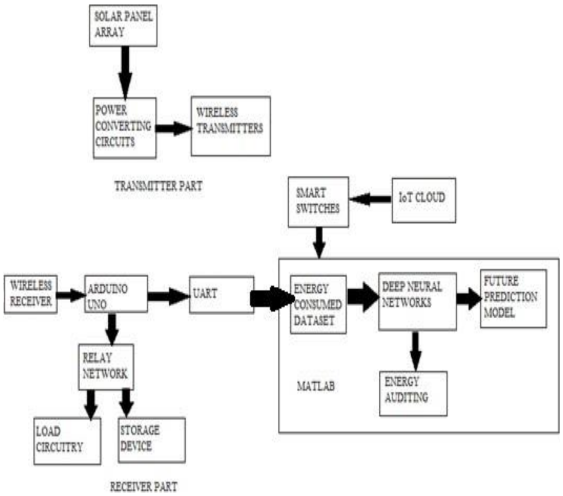

Fig 8. Block diagram of proposed system

SIMULATION OUTPUT:

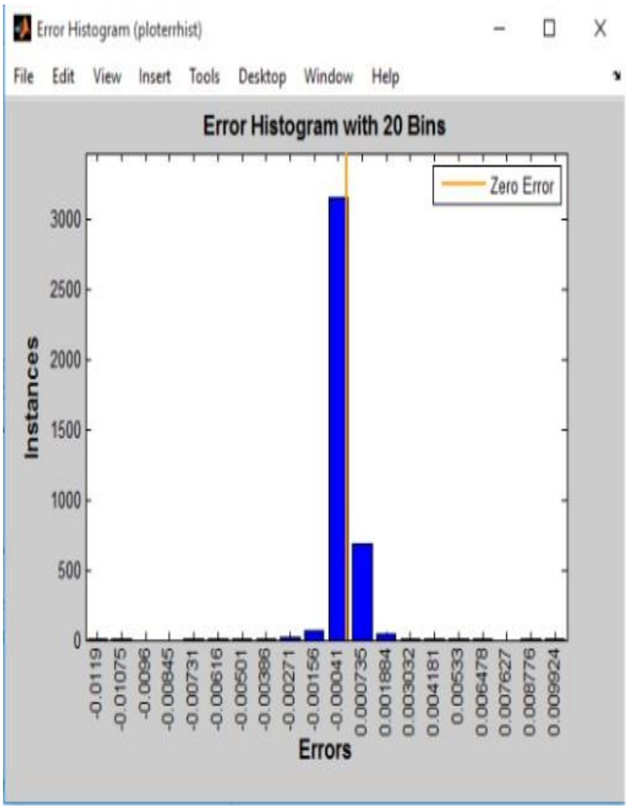

Fig 9. Error Histogram

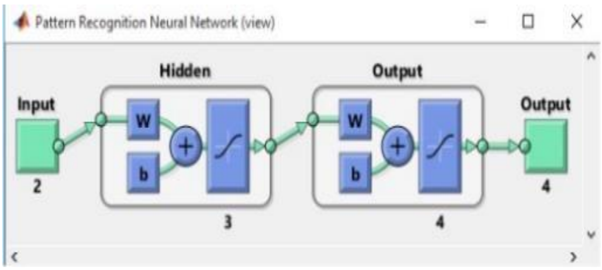

Fig 10. Pattern Recognition Neural network

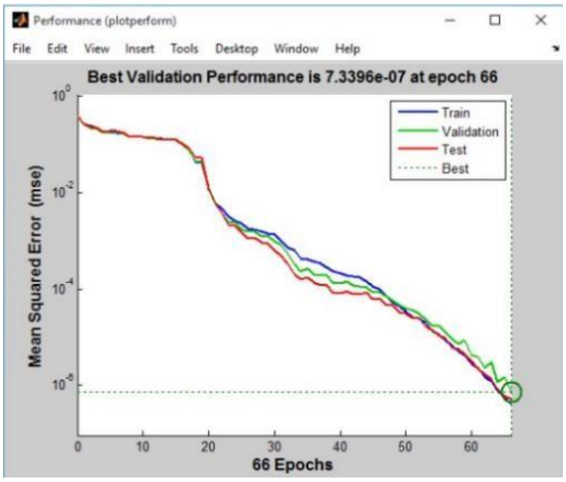

Fig 11. Performance

CONCLUSION

Design of smart power harvesting and distribution network is evaluated, and the design of various switching network is used by the generated power through wireless coils. The various load circuits are connected and energy log is maintained. Configurable load circuits are designed in which energy log is maintained to analyze the future demands and the design of deep neural network is used to analyze the various epoch of input energy data.

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