NEURAL NETWORK BASED DC-DC CONVERTER FOR ELECTRIC VEHICLE APPLICATION WITH PV PANEL

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Abstract

Renewable energy sources are becoming popular for all the automobile industries to replace the conventional energy sources. But the stability of the output is the major concern while moving from conventional energy sources to renewable energy sources. Power electronics plays very important role in the stabilization of the output voltage. Still the stability can be improved by tuning the gate pulses for the power electronics circuits using Machine learning models. Here neural network model has been used to improve the stability of the DC-DC converter. Conversion efficiency can be improved using MPPT techniques. A precise VCO is also used, which can change the switching frequency dynamically based on the input voltage. After being built and simulated on 180nm CMOS technology, the harvester achieves maximum conversion efficiency. The Energy Harvesting (EHFEM) Project for Exercise Machines should respond to changes in real time using an elliptical pedalling action. Exploring the limits of microcontrollers with speeds around or beyond 100 MHz helps to focus future efforts, as the fastest calculation methods are also the most expensive. The viability of adding a neural network into the EHFEM system is investigated in this thesis subject, which compares numerous neural network types. This project uses a feedback control system to regulate a four-switch buck-boost converter utilising an artificial neural network, as well as voltage and current sensing circuits. The impact on system conversion efficiency is also measured in this work.

Keywords: *DC-DC Buck/Boost converter, artificial neural network, Solar panel, Battery, MOSFET.*

1. INTRODUCTION

Conventional energy sources are in a critical stage and may run out soon, causing a severe environmental risk directly or indirectly. Solar energy, the ultimate renewable energy source, is an effective replacement and environmentally benign alternative to electric power generation. DC-DC converters, such as boost converters, are a less expensive, more complex arrangement that requires low inductor and capacitor. For renewable energy applications, this DC-DC converter has a high step up and efficiency with a nominal input voltage of 40 V and an output voltage of 400 V. It also produces much more electricity (400 W). This work also includes a design guideline for selecting the proper integrant value.

To reduce leakage inductance effects and minimise voltage spikes over the power switches, snubber circuits with low power loss and magnetic coupling also provided. The converter's usefulness in renewable energy applications is confirmed by its peak efficiency of 96.2 percent. The main goal is to use a neural network on a PID controller for electric vehicle applications, which is simple to install and minimises the computational load in embedded systems.

Fixed mathematical formulae for predicting software development effort are insufficient due to the imprecision and nonlinearity in software project data, resulting in a high prediction error rate. Artificial Neural Network (ANN) techniques, on the other hand, are very popular[1-3] for predicting software development effort due to their ability to map non linear input with output. A traditional controller demands a lot of computing time, whereas a trained neural network requires less. The artificial neural network is able to generalise and interpolate between training data sets. The ANN controller is ubiquitous because of this advantage of ANN.[4-10] Simulation and experimental results confirm that good dynamic performance and high robustness to parameter variation and disturbance can be achieved by means of the proposed controller.[11]. DC/DC converters are suitable for all the industrial applications [12-17] which will give the reduced ripples compared to other DC-DC converters. There are so many converters are available in the market. But the basic DC-DC converter is used for low power application.

2. METHODOLOGY

2.1 HARDWARE COMPONENTS

2.1.1 SOLAR PANEL

FIG.1.SOLAR PANEL

PV panel sizing is determined by the overall system load, which is the total wattage of the load. PV array size =370/ (0.75*0.85) = 590 W, assuming a PV panel operating factor of 0.75 and a PV panel mismatch factor of 0.85.This application necessitates the usage of four 200Wp, 24V solar panels..

2.1.2 Voltage Regulators

FIG.2.REGULATOR OF VOLTAGE(7812)

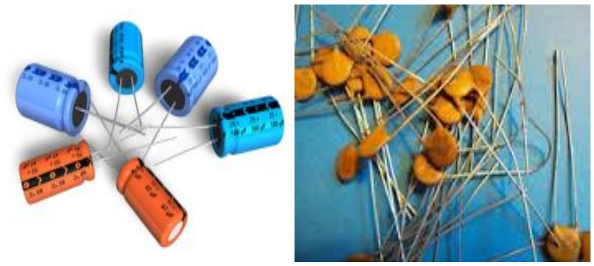
The composition of the ceramic material determines the capacitor's electrical behaviour and consequently uses.

- For resonant frequency applications, Class 1 ceramic capacitors provide excellent stability and low losses.
- For buffer, by-pass, and coupling applications, Class 2 ceramic capacitors provide high volumetric efficiency.

The voltage regulator's job is to keep voltages within safe limits for electrical equipment that consumes that voltage. This device is often used in all sorts of cars to match the generator's output voltage to the electrical load and battery charging requirements.

2.1.3 CAPACITOR

FIG.3.ELECTROLYTIC, CERAMIC CAPACITOR

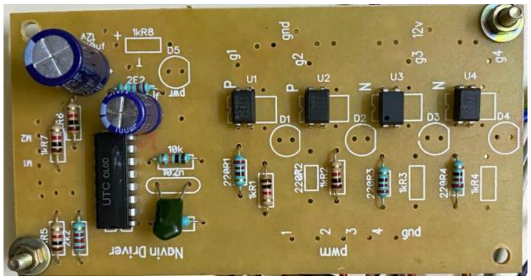


An electrolytic capacitor has one of its plates made of an electrolyte (an ionic conducting liquid) to produce a higher capacitance per unit volume than other types of capacitors. Working voltages of up to 500V are possible for electrolytic capacitors, while the greatest capacitance values are not attainable at this voltage. For regular use, the functioning temperature is 85°C, and for high-temperature.

The composition of the ceramic material determines the capacitor's electrical behaviour.

2.1.6 TLP250 MOSFET DRIVER

FIG.4.TLP250 MOSFET DRIVER



There are two types in the TLP250: an input type and an output type.There is also a power supply setup supplied. MOSFETs and IGBTs benefit from it. This MOSFET driver differs from conventional MOSFET drivers in that it is optically isolated. Its electrical input and output sides are separated by an electrical barrier. However, to carry electrical impulses between the two sides, an optical signal is used. It works in the same way as an opto-coupler.

2.1.7 ATmega328 MICROCONTROLLER

FIG.5.ATmega328 MICROCONTROLLER

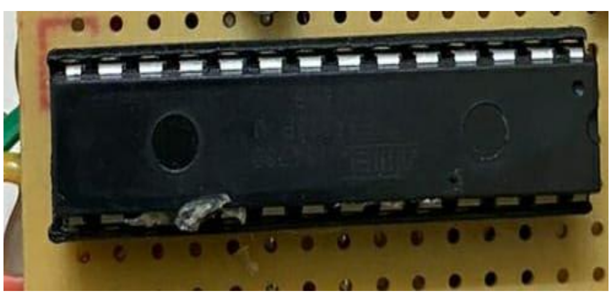
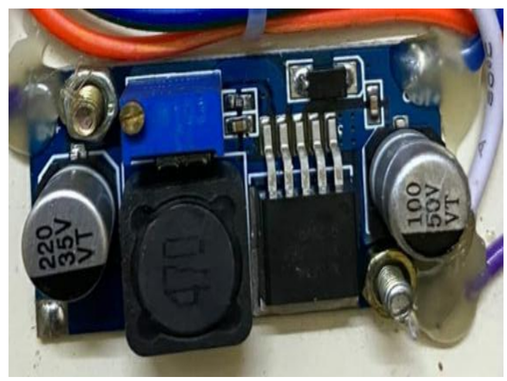


Table.1. Summary Of Microcontroller

Microcontroller	ATmega328
Voltage of Operation	5V
Voltage at Input (recommended)	7-12V
Voltage at I/O(limits)	6-20V
Digital Input Pins	14
Analog I/O Pins	6
DC Current per Input Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

2.1.8 DC-DC BUCK/BOOST CONVERTER

FIG.6.DC-DC BUCK/BOOST CONVERTER



DC-DC converters are very useful in all the industries wherever the high voltage is required from the small voltage sources such as from solar panels, wind energy conversion systems and biomass. Electric automobile motors require very high voltages in the range of 500V and above. To satisfy the high voltage requirement the number of solar panels or number of battery banks may be increased which will increase the cost and weight of the whole system. To rectify this problem, less number of batteries along with the boost converter can be used to increase the DC voltage level to the required level. The battery's life can be increased by using a boost converter to push this low output level back up to a usable level.

2.1.9 BATTERY

FIG.7.BATTERY

The sealed lead acid batteries in the 'Online' range are maintenance-free, valve-regulated, and leak-proof, making them perfect for all standby applications. There will be no reduction in power output as the battery life progresses. Low monthly self-discharge of roughly 2% to 3%, compared to 20-30% for more popular battery systems. To ensure a long service life, quality construction with no compromise on materials is used. A rapid discharge rate is associated with low internal opposition.The battery can work at temperatures ranging from -15° C to +50° C when fully charged.

2.2 SOFTWARE PLATFORM

2.2.1 PROTEUS SOFTWARE

Proteus is excellent simulation software for many microcontroller architectures. In Proteus Simulation Software, you can simulate your microcontroller programming. You can build a PCB design immediately after simulating your circuit in Proteus Software.

- Project setup
- Compile and run
- Writing firmware
- Hardware breakpoints

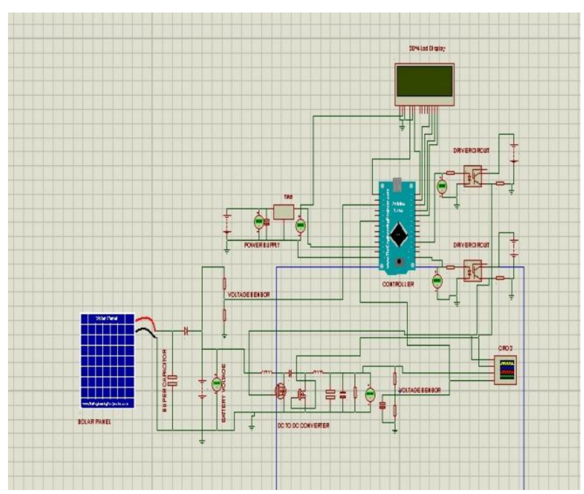
3. SYSTEM IMPLEMENTATION

3.1 CIRCUIT DESIGN

The following items are needed to complete the circuit:

- Solar panel
- Voltage regulator
- Capacitor
- Resistor
- Inductor
- IRFZ44N N-channel Mosfet
- TLP250 Mosfet driver
- DC-DC Buck/Boost converter
- 6voltage-5Ah Battery
- LCD
- LED
- Diode
- ATmega328 microcontroller
- Load

FIG.8.PROPOSED SYSTEM USING PROTEOUS SOFTWARE



3.2 WORKING OF THE SYSTEM

- Solar energy is the primary source of electricity generation in our project. The first stage solar panel (12V, 15W) is connected to a voltage regulator that also serves as a voltage sensor.

- The solar power will charge the 5A battery through the supply capacitor 12V. The charging and discharging operations are controlled by a switch.

- The converter circuits board, which is connected in the circuit to boost the voltage, is given 12V as input power. All of the boost converter boards are linked together, and each one's output is fed into the MOSFET circuit.

- We supply an input pulse (on off timing) to the Gate pin of a MOSFET, which has three inputs: gate, source, and drain. The pulse signal is provided by the ATMEGA238 controller to the MOSFET, but the MOSFET requires a minimum voltage of 10V to turn off.

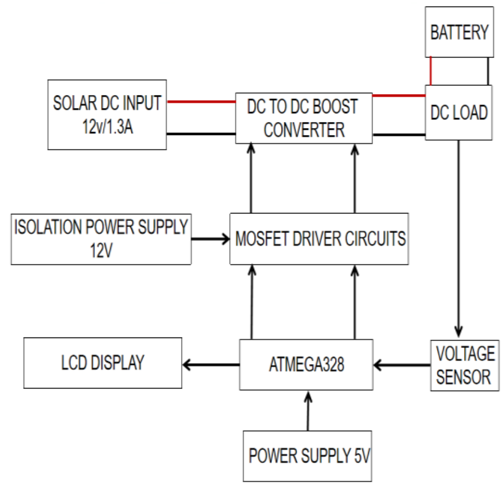
- Because the microcontroller's output is only 5V DC, we used a MOSFET driver circuit to boost the input pulse. The signal is received by the driver circuit.

- The pulse signal to the MOSFET unit is generated by the controller and is dependent on the input signal.

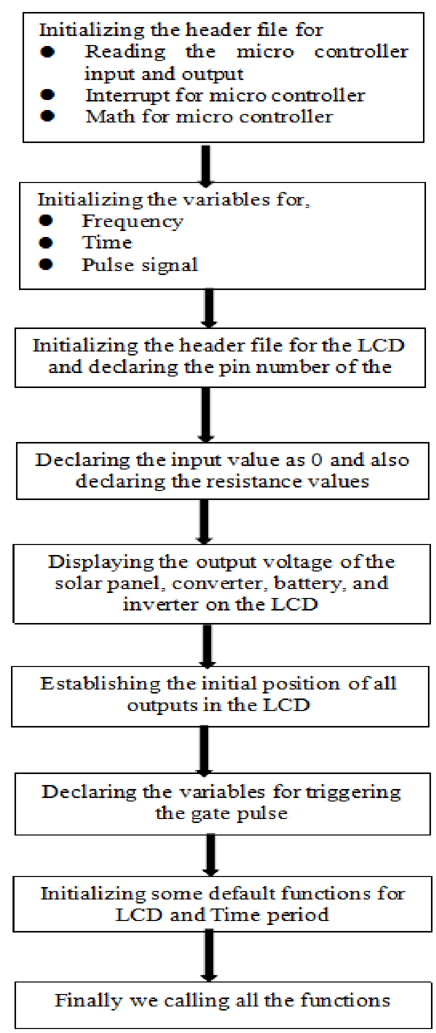
- We have four output loads: a lamp, a connection holder, and voltages of 48V and 12V. We'll use a 1.5w Led for the 12V output and a voltmeter to measure the 48V and AC plug point output.

We will raise the voltage from the 12V input signal to 240V, 48V, and 12V, and demonstrate this in a prototype model.

FIG.9.BLOCK DIAGRAM

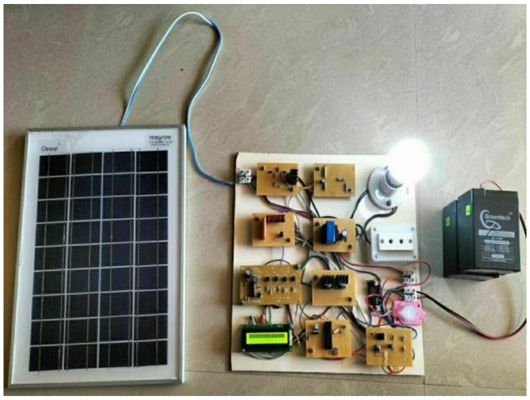


3.2 FLOWCHART FOR MICROCONTROLLER PROGRAM



3.3 WORKING MODEL

FIG.10. HARDWARE WORKING KIT



4.2 DISCHARGING STATE

Table.2. DISCHARGING STATE

Battery Voltage in volts	Time in seconds	Output Voltage from Boost Converter using NN in voltage
12	11:00	343
11.4	11:40	342
10.3	12:20	340
9.2	1:00	341
8.5	1:40	342
7.4	2:20	344
6.3	3:00	341

4.3 AT CHARGING STATE

Table.3. CHARGING STATE

Solar Voltage in volts	Battery Voltage in volts	Time in seconds	Output Voltage from Boost Converter using NN in voltage
12	6.3	11:00	240
12	7.4	11:40	241
12	8.3	12:20	243
12	9.2	1:00	240
12	10.1	1:40	240.5
12	11.4	2:20	242
12	12	3:00	241

The following graph is shown that during charging and discharging of the battery the output voltage is maintained constant because of the neural network model included with the Dc-Dc converter to maintain the stability.

FIG. 11. Output voltage from the boost converter after using NN during discharging

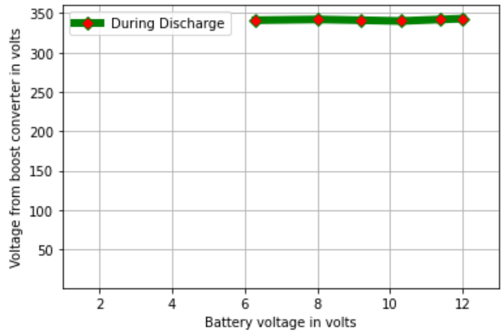
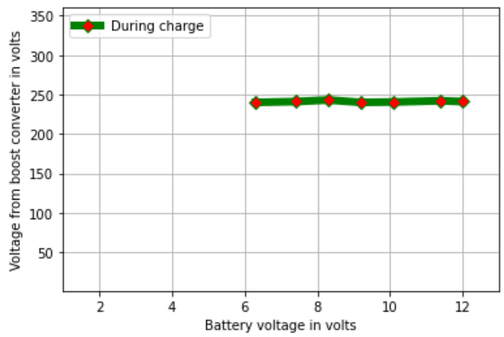


FIG.12. Output voltage from the boost converter after using NN during charging from solar panel.



4. CONCLUSION

The ability of neural networks to manage the voltage on the LT8705 DC-DC converter chip is investigated and validated in this study. Experiments are utilized to assess the overall effects, despite the fact that the datasheet does not define what each input node accomplishes inside the control architecture. The neural network remained stable throughout, which speaks well for future efforts to improve the neural network's efficiency. The neural network ran into a slew of issues, and there wasn't enough time to fix them all. Only a fifth of the room was left for lab research when Andrew Forster finished the DC-DC converter. Unfortunately, during the first design iteration, a few false assumptions regarding the LT8705 control scheme prohibited hardware interfaces from operating correctly. After each hardware design was fixed, setbacks limited the amount of time that could be spent optimising neural networks. Neural network optimization might go on indefinitely, and fine-tuning the initial network weights could minimise converter output voltage overshoot during startup. A digital signal processor could connect with the Atmel SAM4S to do floating point operations more quickly, or more optimization could enhance the Atmel microcontroller code execution speed. The microcontroller caused the DC-DC converter to accept a reduced input range, so this research studied compiler optimization to improve operating performance.

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