Review of PV Based Multipurpose PMSM Drive Using Arduino

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Abstract - **This work propose a review of permanent magnet synchronous motor (PMSM) drive using microcontroller controlled pulses. PMSM has higher efficiency compared to the Induction Motor and Brushless DC motors. To drive PMSM the energy of 3 phase inverter is used, keeping the view the present in this project processes as (SPV) solar photovoltaic powered PMSM. The proposed topology is modelled and it's performance is manifested through simulation using MATLAB.**

Index Terms - **Arduino UNO, Battery, PMSM Drive, Solar Hybrid Charger, Solar photovoltaic System**

I. INTRODUCTION

Solar energy has greatest availability as compare to other energy sources. Solar energy is the most clean energy and easily utilized. The solar energy which is available in our environment can be used to convert into electrical energy by Solar Photovoltaic System (SPV). It is estimated that the earth surface receive 1000 Watts power per square meter during a sunny day. In recent survey the global energy shares of Solar based renewable energy is 24%, although it varies by regions and countries.

In India 21.22% energy shares is due to the renewable energy sources. India has set a goal of 175 GW renewable energy capacity by the year 2022 including 100 GW of Solar.

SPV system has some advantages like it is light weight, simple structure and easy to install, it occupies less space, it is noise free as well as pollution free also it requires less maintenance. SPV array do not produce toxic emission and greenhouse gas. The next improvement in the renewable energy sector is use of SPV based motor drives, nowadays the mostly used motor drives are Induction motors which are widely used in Industries as well as in commercial sector. The SPV motor drives are the better replacement for such motors and also, they are capable of handling such mechanical loads as same as other motors

II. SOME COMMONLY USED MOTORS:

In industries wide varieties of motors are used, the most commonly used motors are as follows-

A. Induction Motor

3 Phase Induction motor is widely used in industries, in which electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding. The rotor of induction motor can be either cylindrical or squirrel cage type.

Three phase squirrel cage induction motors are widely used as industrial drives because they are self-starting, reliable and economical. Single phase I.M. are used extensively for smaller loads or household purpose.

Although the Induction Motor has some disadvantages, during the loading condition the power factor of the motor drops at a very low value, the speed control of the Induction motor is difficult to attain because the Induction motor is constant speed motor, it has poor starting torque hence motor cannot be used for application which require high starting torque, also the single phase Induction motor is not self-starting it requires some auxiliary for starting, the full load motor efficiency is around 85-97%.

Fig.1. Induction Motor

B. Brushless DC Motor

The Brushless DC motor is also known as electronically commuted (EC) motor. These motors are synchronous motors powered by direct current (DC) electricity via an inverter or switching power supply which produces electricity in the form of alternating current (AC) to drive each phase of motor via a closed loop controller. The motor controller provides pulses of current to the motor windings that control the speed and torque of the motor. The rotor consists of neodymium magnets and it surrounds the stator.

The brushless motor is more advantageous over an Induction motor, these motors have high power to weight ratio, high speed, electronic control, and low maintenance.

They have wide range of application in industries as well as other sectors. The main disadvantage of this type of motor is it requires electronic speed controller (ESC) to commutate the motor also it requires extra equipment to provide throttle signal to the ESC.

Fig.2. BLDC Motor

C. Permanent magnet Synchronous motor

This motor is same in construction as that of BLDC motor but there is absence of electronic speed controller also the supply given to the motor is 3 phase AC instead of DC. PMSM are brushless motors and having high efficiency. Due the permanent magnet rotor they have higher torque with smaller frame size and no rotor current, all of these are advantages over an Induction motor. PMSMs have high power to size ratio by using PMSM the design of project becomes smaller as it requires small space without loss of torque.

PMSMs have high power to size ratio by using PMSM the design of project becomes smaller as it requires small space without loss of torque. PMSM has wide range of applications it is used in air conditioner and refrigerator compressor, also it is used in washing machines.

Due to the high torque, high speed, high efficiency, less mechanical vibrations, and economical and well design provided with the good speed control the Permanent magnet synchronous motor is superior to use in any application.

We have studied several research papers based on the PMSM drive and its applications, the methodology behind the project is quite similar.

The applications vary in each research paper shows the effectiveness of the PMSM also it shows the multipurpose use of the PMSM drive. Then we have studied the basic principle and the methodology behind the PMSM drive and its working along with the multipurpose applications.
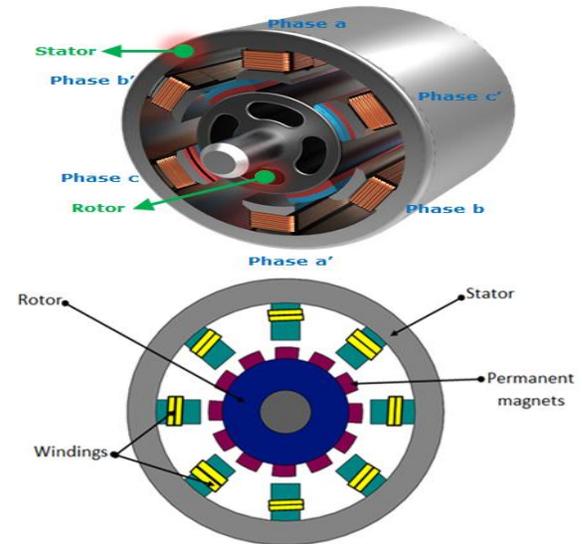

Fig.3. PMSM Motor

Fig.4. PMSM Motor and Motor Driver

III. CHARACTERISTICS OF PMSM

Although the construction of PMSM is similar to the BLDC motor but the characteristics of PMSM is quite different. The back emf of BLDC motor is trapezoidal whereas the back emf of PMSM is sinusoidal in nature. The nature of stator flux linkage in BLDC

motor is not exactly sinusoidal but the stator flux linkage in the PMSM is exactly sinusoidal in nature.
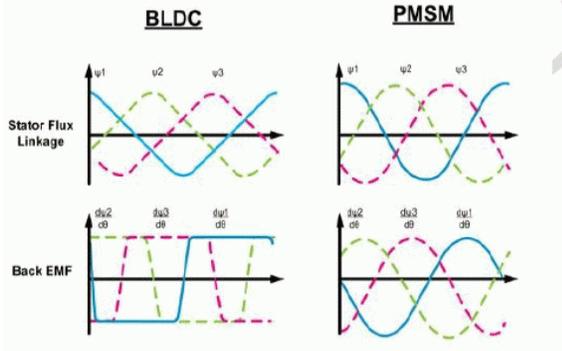

Fig.5. PMSM vs BLDC Waveforms

The speed-torque relation of PMSM are also different as that of BLDC motor. The PMSM requires sinusoidal stator current to produce constant torque. In ideal torque speed characteristic when the speed increases beyond the nominal frequency the motor withdraws more current whereas the back emf starts increasing while the terminal voltage remains constant. The increase in the motor speed thus decreases the motor torque, in ideal conditions the motor torque never decreases up to zero.

Up to the nominal frequency the motor maintains the torque constant and beyond the nominal frequency the motor maintains the constant power.
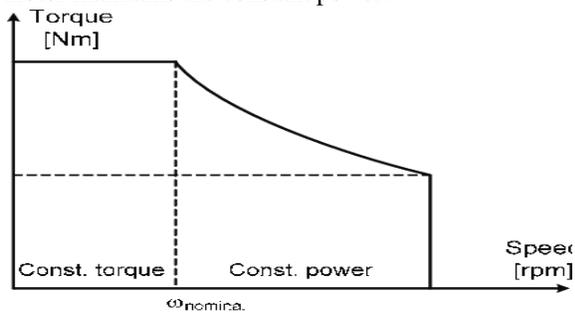

Fig.6. Ideal torque characteristics of PMSM

IV. METHODOLOGY AND THE PRINCIPLE OF OPERATION OF PMSM DRIVE

We have studied the principle behind the working of the PMSM, the PMSM needs 3 phase AC supply for the operation, the power supply is provided by the 3 phase inverter which consist of power electronic switches which converts the DC supply into 3 phase AC. The switching action required for the inverter is provided by the suitable microcontroller.

The PMSM drive gets DC power through the solar photo voltaic cells, but the emf produced by the photo voltaic cells is not sufficient to charge the huge batteries so a boost converter is used to increase the charging voltage to charge the batteries without any interrupt.

The PMSM drive has wide range of the applications, but here in the fig. 1 the PMSM drive is used in the agriculture purpose. The farmers of India are not getting the sufficient electric power therefore the Solar Photo-voltaic PMSM drive is probably the best option for the Indian farmers for the agriculture purpose and it will be more economical for them. The PMSM drive has wide range of applications in the agriculture sector, although the industrial sector needs some improvement before using the PMSM drives.

The PMSM drive has good future aspects due to some advantages like the PMSM drive is simple and economical and also it requires less maintenance and manpower to operate.
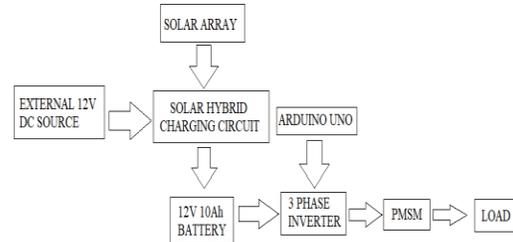

Fig.7. Block diagram of Solar fed PMSM drive using Arduino

V. CONCLUSION

By using the PMSM drive the problems related to the electric power cuts, faced by Indian farmers can be resolved. The PMSM drives powered by the Solar photo-voltaic system are able to overcome the global electric power crisis, and one day the industries and researchers will shift their focus on renewable sources of energy. We have compared the traditional motors generally used in industries and other sectors with the PMSM drive, and we found that the PMSM drives are comparatively more advantageous, efficient, and economical.

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