To Design and Develop A model of Solar Based '3' Level Elevator system

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***Abstract*— Modern high-rise buildings require use of a growing number of elevators that have become important factors in energy consumption. Most of the existing lifts are powered from the grid. In order to reduce grid energy consumption and increase reliability, an improved elevator system which uses Solar power supply is proposed in this project. This system supplies electronic modules of the elevator with renewable sources whenever there is sufficient sunlight and maintains usual work of the elevator. The corresponding architecture of the proposed elevator system and needed battery capacity for correct operation are given in this project.**

The Brushless Direct Current (BLDC) motors have smooth speed control, high power density and less complexities in power converter and controller when operated with dc supply as compared to other electrical motors. the scope of using BLDC motors for elevator systems suitable for their operation. For analyzing the BLDC motor based elevator system, a Four quadrant operation of the proposed elevator system has also been indicated with the simulation results. for the upward and downward movement of the elevator cabin with and without load and the findings are given in the project. Regenerative braking is also possible for the proposed system by employing a suitable gear mechanism in place of worm gear.

Index Terms*— Brushless Direct Current (BLDC) motor, Solar Panel, PIC microcontroller, Elevator, MP lab programming, Battery.

I. INTRODUCTION

AN ELEVATOR is a vertical transportation vehicle used mainly for the transit of people and goods in high-raised buildings Easy and efficient transportation within a building is of utmost importance, since the present day cities are considered to grow vertically. Most of the existing lifts are powered from the grid in order to reduce grid energy consumption and increase reliability, an improved elevator system we use Solar power supply is proposed in this project. This system supplies electronic modules of the elevator with renewable sources whenever there is sufficient sunlight and maintains usual work of the elevator. The corresponding architecture of the proposed elevator system and needed battery capacity for correct operation.

Brushless Direct Current (BLDC) motors have secured a very significant space in the modern drives industry primarily due to the added benefits of a dc input system along with a brushless drive. Various advantages such as, high torque/current ratio, high power density and higher efficiency make these motors very suitable for replacing conventional motors in many systems such advantages of a BLDC motor and also present a new simulation model that can be used for analysis and design of BLDC motors . Many studies have also been carried out to obtain higher efficiency and better control for BLDC motors Further, owing to the ease of control and scope for regenerative braking, considerable amount of research has been carried out to incorporate BLDC motors in Electric Vehicles. Hence, to have such improved performance, the application of BLDC motor has been studied in work of elevator system in vertical transportation.

An elevator system deals with numerous signals and some of those are floor position signal, load sensor signal, door open signal, floor commands etc. Thus the controller designed for the elevator system needs to efficiently organize these signals for operating the system as per the user command. It has have emphasized this aspect and suggested how a PIC Microcontroller can be beneficial for operating elevator systems. The inverter which sources the BLDC motor is supplied from a battery. Solar PV panels are integrated to the battery through power converter. The BLDC motor is coupled to the elevator system through a worm gear and is responsible for the motion of the EC. The EC and CWs are connected via suspension cables. To have the proper movement of the elevator system, suspension cables are guided through a mechanical pulley. This pulley is coupled with a BLDC motor-worm gear system. Hall sensors have been used for identifying the rotor position of the BLDC motor. Similarly, magnetic position sensors have been employed for sensing the elevator position, i.e., floor level.

BLDC motor rotation is initiated by sequentially energizing the three phase winding of the stator with the appropriate polarity. This is achieved by controlling the sequence of conduction of the IGBTs in the inverter, based on the instantaneous position of the rotor. the conduction of the IGBTs in the inverter for operating the BLDC motor in forward and reverse directions. It can done by conducts two switches at any instant with one on the top leg and the other from the bottom leg. Further, the speed of the BLDC motor can be controlled by feeding a variable voltage to the stator. the switch pulses for the IGBTs in the inverter for rotating the BLDC motor in forward direction. The magnitude of the voltage can be varied by using pulse width modulation (PWM). To have the minimum switching loss, a constant pulse of 120 degree has been maintained for the switches in top leg and multiple pulses are given to the switches in the bottom leg in each cycle. The pulses given to the inverter have been controlled using PIC microcontroller by taking appropriate feedback signals, namely, rotor position of BLDC motor, elevator position (i.e., floor position) and user commands the elevator system proposed in this project operates in four quadrants depending upon the (1) relative weight of the EC and CW and (2) direction of movement of EC. it is to be noticed that in quadrants i and iv, the EC is with passenger while in quadrants ii and iii it is empty. upward motion of the EC corresponds to the forward rotation of the BLDC machine and reverse rotation is for downward motion of EC.

II. Description Of The Proposed Elevator System

Fig. 1 shows the block diagram of the proposed system. The inverter which sources the BLDC motor is supplied from a Inverter. Inverter is integrated to a Solar through charging circuit. The BLDC motor is coupled to the elevator system through a worm gear and is responsible for the motion of the EC. The EC and CWs are connected via suspension cables. To have the proper movement of the elevator system, suspension cables are guided through a mechanical pulley. This pulley is coupled with a BLDC motor-worm gear system. Hall sensors have been used for identifying the rotor position of the BLDC motor. Similarly, magnetic position sensors have been employed for sensing the elevator position, i.e., floor level.

A. BLDC motor control

BLDC motor rotation is initiated by sequentially energizing the three phase winding of the stator with the appropriate polarity. This is achieved by controlling the sequence of conduction of the IGBTs in the inverter, based on the instantaneous position of the rotor. Table I shows the conduction of the IGBTs in the inverter for operating the BLDC motor in forward and reverse directions. It can be noticed from this table that, two switches conduct at any instant with one on the top leg and the other from the bottom leg.

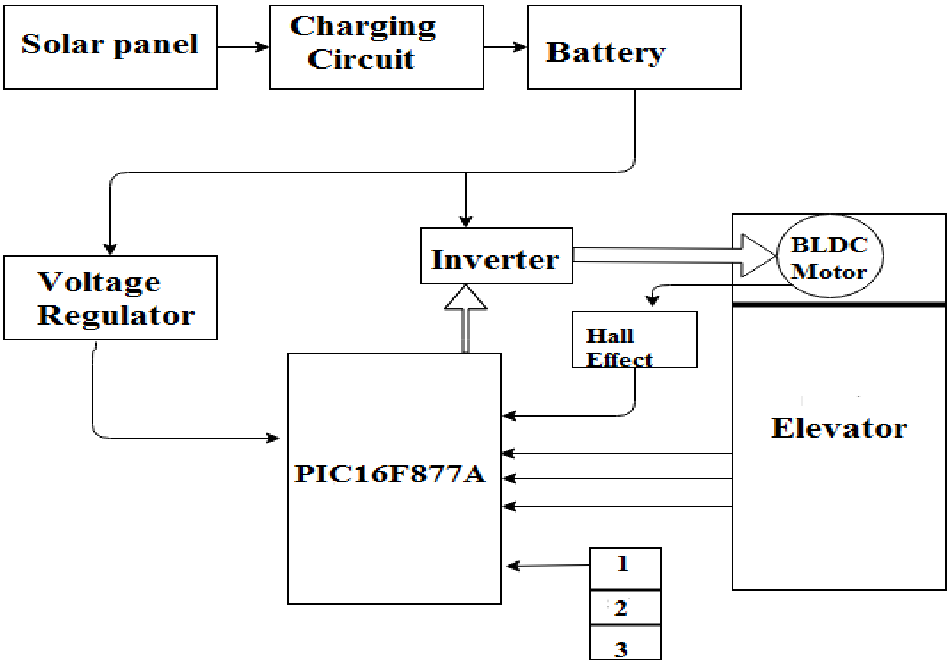

Fig.1 Block diagram of solar based Elevator system

TABLE I
HALL SENSOR OUTPUT AND CORRESPONDING SWITCHES TO BE SWITCHED ON FOR FORWARD AND REVERSE ROTATION OF THE BLDC MOTOR

Hall Sensor Signals			Switches in conduction	
Phase A	*Phase B*	*Phase C*	*Forward Rotation*	*Reverse Rotation*
0	0	1	S_2,S_3	S_6,S_5
0	1	0	S_4,S_5	S_2,S_1
0	1	1	S_4,S_3	S_6,S_1
1	0	0	S_6,S_1	S_4,S_3
1	0	1	S_2,S_1	S_4,S_5
1	1	0	S_6,S_5	S_2,S_3

Further, the speed of the BLDC motor can be controlled by feeding a variable voltage to the stator. Fig. 2 shows the switch pulses for the IGBTs in the inverter for rotating the BLDC motor in forward direction. The magnitude of the voltage can be varied by using pulse width modulation (PWM). A 5 kHz carrier signal has been used for generating the PWM signals. To have the minimum switching loss, a constant pulse of 120□ has been maintained for the switches in top leg and multiple pulses are given to the switches in the bottom leg in each cycle. The pulses given to the inverter have been controlled using PIC microcontroller by taking appropriate feedback signals, namely, rotor position of BLDC motor, elevator position (i.e., floor position) and user commands.

B. Four quadrant operation of an elevator

The elevator system proposed in this paper operates in four quadrants depending upon the (i) relative weight of the EC and CW and (ii) direction of movement of EC. The four quadrant operation of the elevator system is shown in Fig. 3. It is to be noticed that in quadrants I and IV, the EC is with passenger while in quadrants II and III it is empty. Upward motion of the EC corresponds to the forward rotation of the BLDC machine and reverse rotation is for downward motion of EC. In the first quadrant, the net EC weight is assumed to be more as compared to the CW and EC needs to move upward. Hence, the BLDC machine operates as a motor (forward motoring) with torque and rotational speed in the same direction as indicated in Fig. 3. Similarly, the BLDC machine operates as a motor (reverse motoring) in the third quadrant as the net EC weight is less as compared to the CW and EC moves downward. In the second quadrant, the net EC weight is assumed to be lighter than the CW and EC needs to move upward. So, the BLDC machine acts as a brake (forward braking) with torque and rotational speed in the opposite direction along with the worm gear. The primary objective of worm gear in elevator system is to work as a natural brake such that the EC does not move due to the difference in net EC weight and CW with gravity. Thus, the presence of worm gear forbids any reverse mechanical power flow. If suitable gear arrangement is employed in place of worm gear then the BLDC machine can act as a generator (i.e., regenerative braking) in II quadrant. Similarly, the BLDC machine acts as a generator or brake (reverse braking) in the IV quadrant.

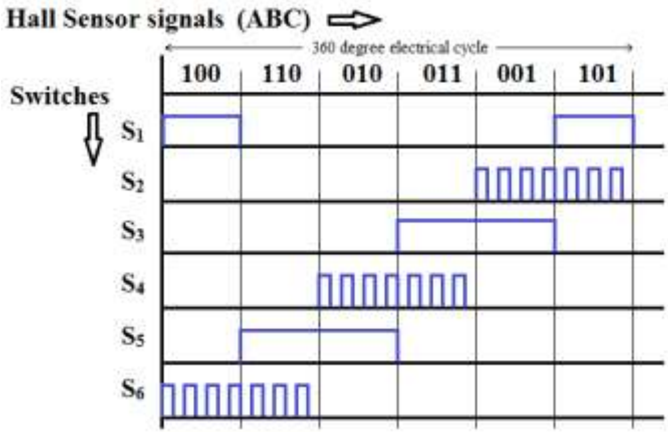

Fig. 2. Switching pulses for IGBTs for the BLDC motor rotation in forward direction.

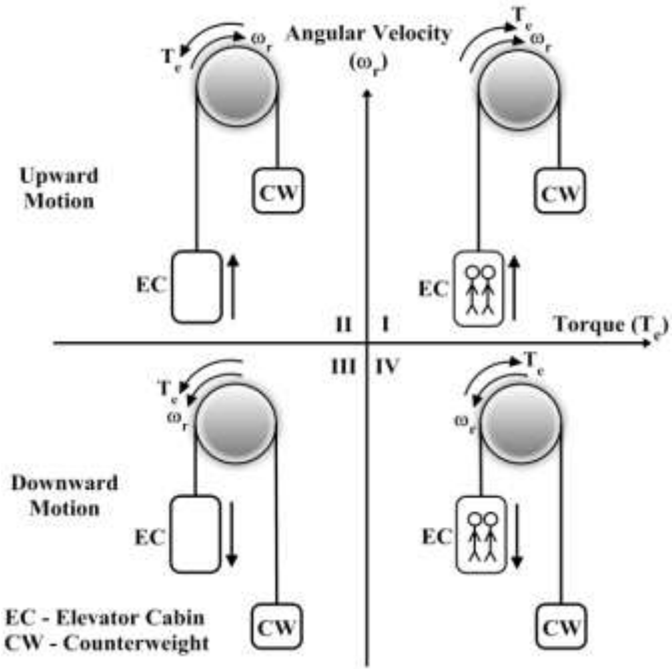

Fig. 3. Four quadrant operation of an elevator system.

III. DEVELOPMENT OF THE PROTOTYPE ELEVATOR SYSTEM

To demonstrate the working and usefulness of the proposed system shown in Fig. 1, a prototype elevator system with BLDC motor has been constructed in the laboratory. A three-phase inverter using IGBTs along with the PIC microcontroller has been employed for feeding control voltage to the BLDC motor.. The specifications of the structure of this prototype elevator system are listed in Table II.

A worm gear setup has been chosen for safety purpose. The gear ratio for the worm gear has been calculated by considering (i) the maximum speed of the BLDC motor, N_m = 2,700 rpm, (ii) diameter of the pulley, D = 0.3 m, and (iii) operational speed of elevator, S_e = 0.3 m/s. Then, the speed of the gear box (i.e., speed of the pulley), N_g in rpm with the gear ratio R_{WG}: 1 is obtained as 19.09 rpm using

TABLE II
SPECIFICATIONS OF THE MECHANICAL STRUCTURE OF THE PROTOTYPE SYSTEM

S. No.	**Component**	**Specification**
1	Dimensions of structure	600mm x 1200mm
2	Length of rails	1200mm
3	Dimensions of cabin	400 mm x 400 mm x 400 mm
4	Dimensions of floor	210mm x 270mm
5	Height of Floor	1mm
6	Material used for structure	mild steel
7	Diameter and material used for pulley	0.04 m made of cast iron
8	Diameter of the elevator cables	5 mm
9	Elevator cabin (EC) weight	0.1Kg
10	Height of project	1200mm

So, N_g is taken as 19.09 rpm. Thus, the gear ratio for the worm is, R_{WG} =135 (=N_m/N_g). Hence, the worm gear has been fabricated with the gear ratio 135:1 for the prototype elevator system As the hardware set-up proposed here is not readily available off-shelf, it enforced few major technical challenges while fabricating the scaled down system. Identifying the appropriate vendors for supplying these components and assembling together has been a difficult task. Further, replacing the worm gear with other appropriate gear mechanism to achieve regenerative braking is a complex process and will be considered as future scope for this work.

Three hall effect sensors have been placed, one at the top, one in the middle and one at the bottom of the elevator structure for detecting the position of the EC. The three signals from the Hall sensors and three signals from the cabin position sensors are fed to the PIC microcontroller after appropriate signal conditioning. Three floor buttons provide the commands to the controller for the EC to move to any floor as per the user requirement. LED driver circuit has been used to glow the LEDs for indicating the floor to which the EC is moving.

IV. CONCLUSION

The main goal of this project is to optimize the power supply and the control drive system in order to achieve energy efficiency and reliability. To improve the energy saving performance, for supplying electronic modules in the existing elevators, as a novelty we propose to partially replace the usage of grid energy, as the main energy source, with a renewable source (sunlight in our case).To solve the problem of a sudden failure of the power supply in elevator systems we propose usage of battery backup supply based on renewable energy. In our proposal the battery is continuously charged by the solar panel instead of the mains power as in conventional solutions.

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