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Renewable Energy Based Elevator System By Using BLDC Motor

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ABSTRACT

In recent days, utilization of renewable energy sources has been emphasized in high-raised buildings. It is known that 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. Hence, this paper enunciates the scope of using BLDC motors for elevator systems suitable for operating with dc micro grid. A PROTEUS 8 Professional simulation model has been developed utilizing the various electrical and mechanical components available in Simulink library for the proposed elevator system. The efficacy and successful working of the proposed system has been demonstrated with the help of a three floor prototype laboratory model developed for this purpose. This prototype model consists of (i) mechanical components, such as worm gear, pulley and EC, etc., (ii) set of sensors for detecting floor position and rotor position of the motor, (iii) user command buttons, (iv) LED indicators and (v) BLDC motor along with power and PIC control circuits.

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I. INTRODUCTION

A 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. Generally an elevator uses a three phase induction motor to carry out the hoisting operation. However, considerable research has been carried out to replace the conventional motor to attain improved efficiency, reliability and speed [1].

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 , cite such advantages of a BLDC motor and also present a new simulation model that can be used for analysis and design of BLDC motors [2]. 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 (EVs) . Hence, to have such improved performance, the application of BLDC motor has been studied in this work for elevator system in vertical transportation [1].

An elevator system deals with numerous signals and some of those are floor position signal, load sensor signal, door open signal, alarm, 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.

II. LITERATURE REVIEW

A. Development of BLDC Motor Based Elevator System Suitable for DC Microgrid

A 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. Generally an elevator uses a three phase induction motor to carry out the hoisting operation. However, considerable research has been carried out to replace the conventional motor to attain improved efficiency, reliability and speed.

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B. Instrumentation and Control of a High Power BLDC Motor for Small Vehicle Applications

A.Brushless DC (BLDC) motors are becoming an increasingly popular motor of choice for low powered vehicles such as mopeds, power assisted bicycles, mobility scooters, and in this reported application, motorised mountain boards. With rapid developments in technology, high energy density batteries such as Lithium-ion Polymer batteries are becoming more affordable and highly suitable for such vehicles due to the superior charge rate and light weight of the lithium chemistry batteries.

A BLDC motor controller was developed specifically for the motorised mountain board application. The motor controller is a sensored BLDC motor controller which takes inputs from Hall Effect sensors to determine the rotor position. Many other sensors are used to monitor the variables that are critical to the operation of the motor controller such as the motor phase current, battery voltage, motor temperature, and transistor temperature.

III. BLOCK DIAGRAM

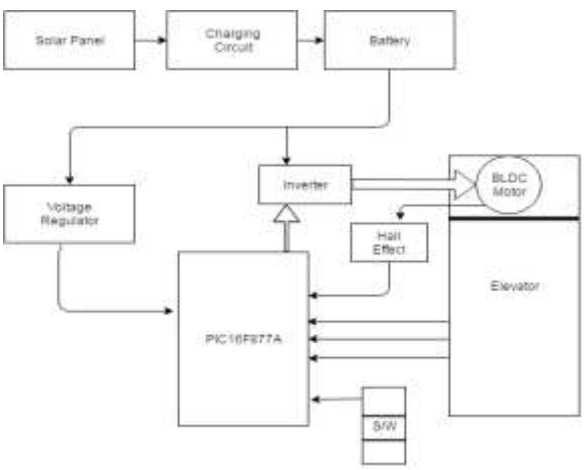


Figure 1: Overall setup of the proposed prototype elevator system

The inverter which sources the BLDC motor is supplied from Solar PV panel. The BLDC motor is coupled to the elevator system through a worm gear and is responsible for the motion of the elevator cabin (EC). The elevator cabin (EC) and counter weight (CW) 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 Using a Variable DC Link Six-Step Inverter:

For standard BLDC motors, a power stage with a 3-phase inverter is used. Control is provided by applying PWM waveforms to the MOSFETs of the 3-phase inverter. However, there are small high-speed BLDC motors with very low inductance. If PWM is applied to the MOSFETs of the 3-phase inverter of such a motor, the current waveform will copy the PWM voltage waveform. Such a current waveform will rapidly and frequently magnetize and demagnetize the metal causing huge thermal losses due to magnetic hysteresis. Therefore, these BLDC motors require a pecial power stage with a variable DC link six-step inverter. The power stage uses six power transistors fully turned on/off to control the commutation. The voltage level is controlled by two transistors in the variable DC link six-step inverter[3].

The variable DC link six-step inverter controls the voltage on the motor, while commutation is performed by the 3-phase inverter. The variable DC link six-step inverter output is controlled by switching the DCDC-Top MOSFET. Thus, the variable DC link six-step inverter uses the inductor L and the capacitor C to keep output voltage at the desired level.

B. PI Controller

PIC 16F877 is a 40-pin 8-bit CMOS FLASH Microcontroller. The core architecture is high performance RISC CPU with only 35 single word instructions .all single cycle instructions take only one instruction cycle except for program branches which take two cycles. It has two types of internal memories :program memory and data memory.

Program memory is provided by 8K word or 14 bits of FLASH Memory. data memory has two sources, one type of dada memory is a 368-byte RAM (Random access memory) and the other is 256-byte EEPROM. (Electrically erasable programmable ROM).

IV. FIGURE AND TABLE

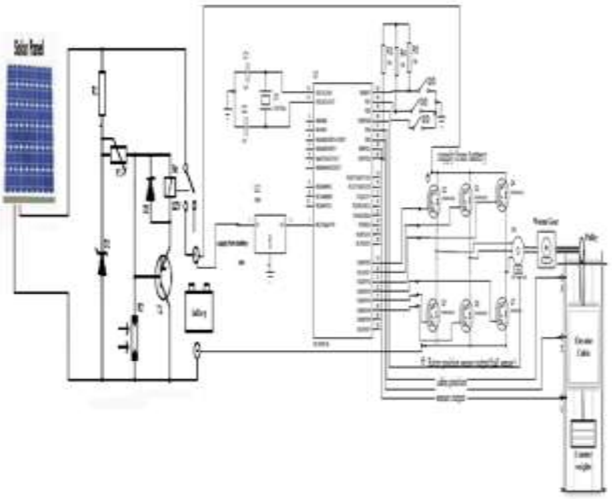


Figure 2: Circuit diagram of renewable energy based elevator system using PI Controller

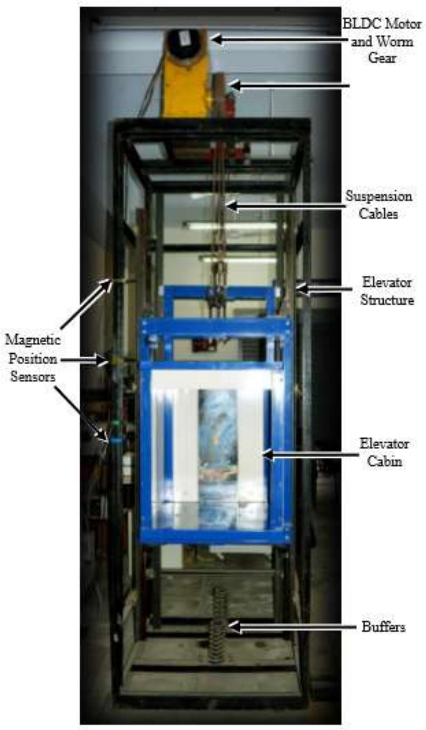
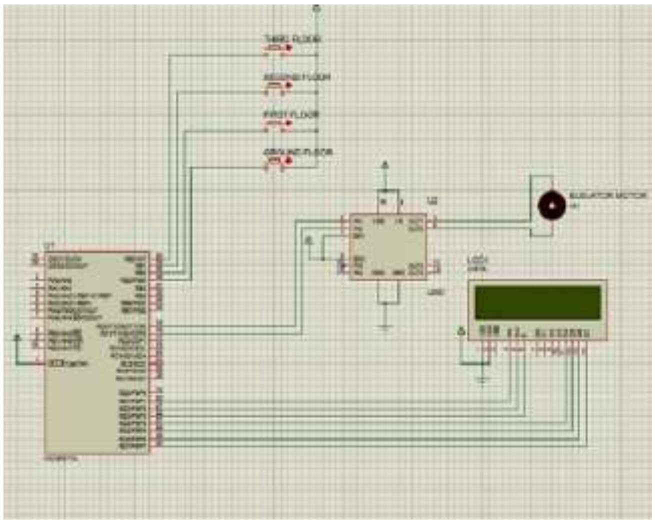


Figure 3: structure of elevator system

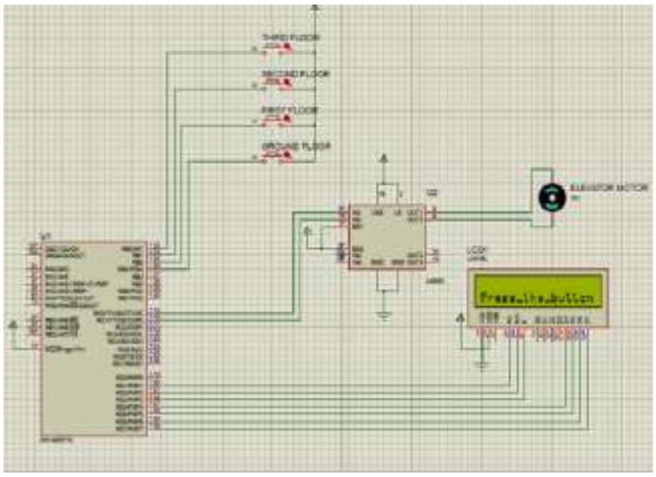
V. SIMULATION

A PROTEUS 8 Professional simulation model has been developed utilizing the various electrical and mechanical components available in Simulink library for the proposed elevator system. The simulation input and output results shown in below figure.

A. Simulation input



B. *Simulation Output*



VI. CONCLUSION

A PROTEUS 8 Professional imulation model has been developed utilizing the various electrical and mechanical components available in Simulink library for the proposed elevator system. The performance of the system has been analyzed with the help of this model. The efficacy and successful working of the proposed system has been demonstrated with the help of a three floor prototype laboratory model developed for this

purpose. This prototype model consists of (i) mechanical components, such as worm gear, pulley and EC, etc., (ii) set of sensors for detecting floor position and rotor position of the motor, (iii) user command buttons, (iv) LED indicators and (v) BLDC motor along with power and PIC control circuits. the analysis of the system through PROTEUS 8 simulation and its successful working. The logic for operating the elevator system as per the user commands in closed-loop has also been developed and tested for its successful working with the prototype model. This aspect will further give better scope for utilising the renewable energy sources available in the high-raised buildings.

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