Microcontroller Based Stepper Motor Drive for an Elevator System

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Abstract—*This paper addresses a microcontroller based unipolar stepper motor drive used for an elevator system. The elevator system developed can move up and down, along with the feature of floor display indicator incorporated in it. The opening and closing of elevator doors are indicated with green and red LED's respectively. The elevator system is divided into four floors of equal heights, so that the stepper motor took equal number of steps while moving from one floor to another. The elevator system is operated using micro switches, the control program is developed in C language and Kiel compiler is used to converts this control program into executable file or say in a HEX code.*

Keywords:-*Microcontroller, stepper motor, LCD and LED*

I. Introduction

Introduction includes the brief discussion of microcontroller, stepper motor drives and the applications of microcontroller and stepper motor. Stepper motors with microcontrollers are used in numerous applications when there is need of controlling the motion. This is due to the robust structure of stepper motor, absence of brushes and better control capability when they are used with microcontrollers. These motors have excellent response to starting, stopping and reversing. The microcontroller is used for sending control pulses to the stepper motor drive. The microcontroller is used both to control the speed as well as position of stepper motor. The speed of stepper motor is directly proportional to the frequency of drive input pulses which is controllable with the help of microcontrollers and the rotation is proportional to the number of output pulses.

II. Literature Review

There is a vast amount of literature related to the Microcontroller based stepper motor drive for an elevator system. The aim of this research is to choose a new sensor less technology for controlling the position of stepper motor for an elevator system. There are different techniques for controlling the stepper motor such as fuzzy logy, neural network and microcontroller. Microcontroller finds a best method for controlling the position of stepper motor. Different types of drives are used to operate the stepper motor because the microcontroller output is not sufficient to operate the stepper motor. Out of all drives ULN2003 is a less costly drive IC for stepper motor. The real time information of the elevator moving through the floors is displayed with the LCD. After each stop of stepper motor the opening and closing of the door of elevator is represent by two LED"s. The control program is written in C language and Kiel compiler software is used to change this high level program into HEX code. By using DScope we can download this HEX code to the 89S51 microcontroller for position control purposes.

Literature has been reviewed through Indian and International journals, books, conference paper etc. The literature collected is conceptual articles surveys and reviewed articles.

Stepper motors and microcontrollers are used in many applications like position control, speed control and measurement applications. Different applications and controlling techniques are described by different authors in this literature review. Microcontrollers and stepper motors are widely used in elevator system. Different types of elevator systems based on stepper motor and microcontroller are also described in this literature review. An elevator is a transport device used to move goods or people vertically. In British English and other Commonwealth English, elevators are known more commonly as lifts, although the word elevator is familiar from American movies and television shows. In the 1800s, with the advent of electricity, the electric motor was integrated into elevator technology by German inventor Werner von Siemens. With the motor mounted at the bottom of the cab, this design employed a gearing scheme to climb shaft walls fitted with racks. By 1903, this design had evolved into the gearless traction electric elevator, allowing hundred-plus story buildings to become possible and forever changing the urban landscape. Multi-speed motors replaced the original single-speed models to help with landing-leveling and smoother overall operation. Electromagnet technology replaced manual rope-driven switching and braking. Besides, Push-button controls and various complex signal systems modernized the elevator even further. Safety improvements have been continual, including a notable development by Charles Otis.

- T.S. Weerakoon (2010) described a novel drive topology for a five phase stepper motor in detail. This paper presented that a low cost, standard stepper motor drive IC are used to derive a novel drive topology for five phase stepper motor which enables closed loop speed and position control powered by inner current control loop. The designed driver have full-step, half-step, clockwise and counter clockwise drive modes with the speed control and current control.
- S.G. Abeyratne (2010) gave simplification about how we can transfer the stored energy in the inductance winding of uni-polar stepper motor when semiconductor switches are off. Author designed a circuit having no zener suppressors and condensers which are used mostly in unipolar drive circuit in industries for the protection of driving circuit from over voltages due this stored energy. Author implemented fast recovery diodes which are capable of transferring this stored energy back to the system and also enhances the torque capability of motor.
- Zhang Yagunet. al (2008) presented a design of elevator system. 89S52 microcontroller is used to control the position of elevator system. LCD is used to display the real time information of elevator. IR sensors are connected to every floor which detects the position of the elevator. The L298 driver is used to operate the

stepper motor. MCU is used to controls the speed as well as position of the stepper motor.

- G.S Barlow et. al (1995) designed a microcontroller based automatic feed mixer with the aim of optimizing the efficiency and consistency of the mixer. Peristaltic pumps and stepper motor control the quantity of liquid nutrient additives and microcontroller is employed for controlling the speed of stepper motor.
- Pullen et. al (2005) proposed a controlling system to reduce the fuel consumption and emissions by the regeneration of braking energy and minimizing inefficient part load operation of engine by using microcontroller and stepper motor.
- J. Barrow et. al (1995) developed an integrated chip for colornon impact printer and motor control system. The two IC"s include three switch mode PWM controllers, two unipolar stepper motor drives, a DC motor H bridge, a serial control post and a host of peripheral system functions. The controller is used to control the speed as well as position of the stepper motor.
- Mountinhoet. al (2003) described a surveillance system for forest environment and protects the natural area from fire. The stepper motor is used for moving the digital camera vertically and PIC 16F877 microcontroller is used to control the motion of stepper motor. This system also captures the humidity, wind speed and direction.
- Zarar Bin Mohammad Jenu (2010) designed a stepper motor based position controlling system for a antenna and a turntable for measuring the electromagnetic field of a electrical or electronics component located at open area for testing. The stepper motor and a DC motor are used to drive the turntable and antenna positioning device. Microcontroller is used to control these motors.
- Ross Bannatyneet. al (1998) introduced 89S51 microcontroller based applications, overview, pin configuration and working. This paper also introduced about the software tools used in programming.
- Chin Ming Hsu et. al (2009) constructed a set of 89S51 microcontroller teaching tool for students to learn the basic knowledge of microcontroller system designing, software simulation tools and flash downloading tools.
- XiahuaZhangxet. al (1998) presented a stepper motor control system is which adopted high performance AVR microcontroller Atmega128 and serial communication. The system mainly consists of host computer, console and a stepper motor. The data is interacted by the serial port between PC and console. Ultimately, the direct control of stepper motor by the PC is achieved. After debugging of the designed control system, the results demonstrate that the control circuit and program are simple and practical.
- Archan Patel et. al (2010) proposed the design and hardware implementation of bipolar micro-stepping drive for disc rotor type stepper motor. This type of motor has advantages like high torque at high speed, very low moment of inertia and low power consumption. The micro-stepping control improves the positioning accuracy; eliminate low speed ripples and resonance effects.
- V Marcenoet. al (2006) presented a novel fully integrated 65W stepper motor driver IC. It is capable of control up-to two stepper motors and four DC motors. This IC is fully protected and programmable and reduced the need of external components for protection due to in built protection facility with high flexibility.
- Hiufenq Jiao et. al (2011) developed a stepper motor based tracking system for increasing the efficiency of photovoltaic panel. The stepper motor is so controlled by microcontroller that it is always incident to sunlight at a angle of 90 degree. Position sensors are used to control the position of stepper motor.
- HilniFadzilet. al (2010) designed a mechanical structure for solar tracker based on stepper motor. The circuit consists of two stepper motors for driving the solar panel, a microcontroller for controlling the stepper motors and a pyranometer for measuring the intensity of solar radiations. The solar panel moves in the direction where the pyranometer receives maximum radiations.
- Xiweiet. al (2010) designed a microcontroller and stepper motor based system which automatically measure and dynamically track the water level in the rivers. For this purpose AT89S52 microcontroller, position detection sensor, display module and a stepper motor is used for measuring and displaying the water level.

III. PROBLEM FORMULATION

From the literature survey it is evident that different controlling techniques are used for controlling position and speed of stepper motor. Out of all the techniques Microcontroller is one of the easiest technique for controlling the speed and position of stepper motor. The speed of the stepper motor is controlled by changing the delay time of pulses and control over the position is done by controlling the number of pulses. Also unipolar stepper motor is better than a bipolar motor because of the reduced step angle and there is no need of reversal of the current in the unipolar drive for changing the rotation of stepper motor. As in microcontroller we can change the control program according to the need with serial port programming by a personal computer.

IV. METHODOLOGY

The design project is divided into four floors of equal distance ground floor, First floor, second floor and third floor. The stepper motor is connected to the elevator lifting pulley with belt as shown in the figure. The stepper motor pulley will took 40 full rotations to lift the elevator to cover the distance from one floor to another. The LCD displays the following real time information about the elevator for a example UPWARDS while moving upwards , DOWNWARDS while moving downwards, STILL when elevator is at stop position and also giving the information about the floor in which the elevator moving and stop. The Micro switches are used to select the desired location for elevator. After reaching at desired floor after some, delay green LED glow which represents the opening of elevator door and after five sec delay green LED off and red LED glow which represents the closing of elevator door. After some delay this red LED off. The floors are made from iron

sheets and the elevator is made up of steel sheet of low weight

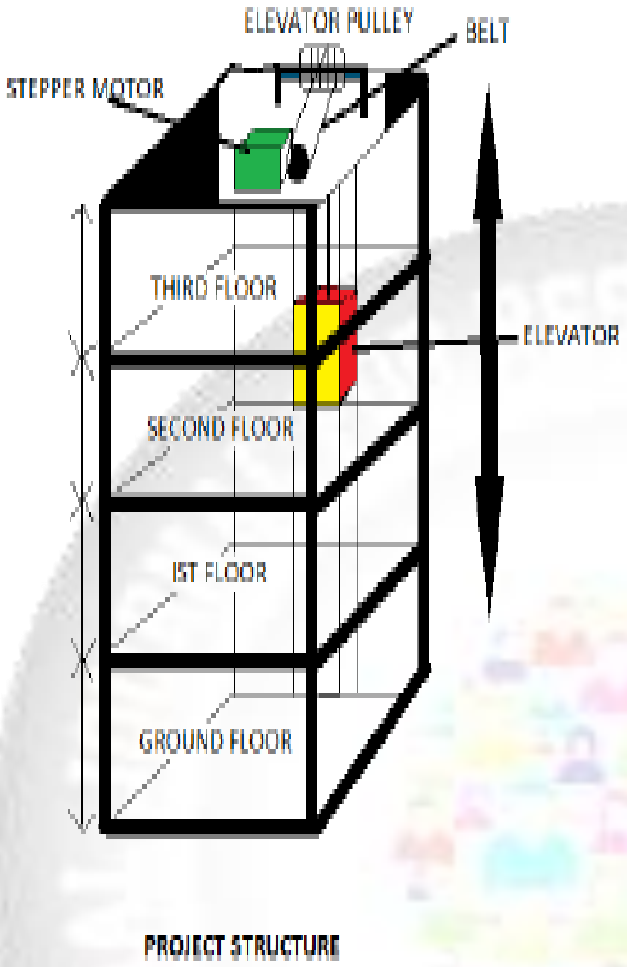

Fig. 1: Project Structure

A. Methodology Procedure followed

All the components of the hardware except transformer required DC supply for working such as LCD, ULN2003, 89S51 Microcontroller and stepper motor. For fulfillment of this need diode rectifier is used in bridge connected configuration for changing AC to DC for all the components. The Microcontroller pins XTAL1 and XTAL2 are connected to a frequency oscillator for frequency stability purposes. The non electrolytic capacitors are connected with this crystal oscillator for changing the triangular pulse to rectangular pulse. The ULN2003 IC connected with six wire unipolar stepper motor required control pulses on its input pins for operation which he receives from the Microcontroller. We use drivers because the microcontroller output is not sufficient to drive the stepper motor.

B. Software Implementation

```
#include<lcdrout.h>
#include<stepper.h>
#define l1 P02 / Define port 2.
#define l2 P03 / Define port 3.
#define l3 P04 / Define port 4.
#define s1 P31 / Pin 3.1 connected to ULN.
#define s2 P32 / Pin 3.2 connected to ULN.
#define s3 P33 / Pin 3.3 connected to ULN.
#define s4 P34 / Pin 3.4 connected to ULN.
#define red P26 / pin 2.6 connected to red LED.
#define green P27 / Pin 2.7 connected to green LED.
void main()
{ Controlling Program
}
```

V. Results & Conclusion

The applications of permanent magnet stepper motors have grown significantly in recent years in the appliance industry and the automotive industry, among others. These motors are used in a variety of industries, including high and low propulsion technology, computer peripherals, machine tools, robotics, etc. Sensor-less permanent magnet motors are preferable to encoder based systems because of compactness, low cost, low maintenance, and high reliability. This project shows by making small changes during programming we can reduce the overall cost of elevator because need of sensors is totally removed. Moreover programming is also helps to display the running status of elevator through LCD and also display the floors through which the elevator is moving and stops.

VI. FUTURE SCOPE

As for the future work, first of all we can implement the sensor less technique using a faster microcontroller. We can also control the speed of stepper motor to save the time when the elevator moving from ground floor to third floor or higher floors or from higher floors to lower floors because in this project the stepper motor speed is constant it takes more time for moving from higher floors to lower floors or vice-versa. For saving the time stepper motor moves faster from one building to another just before reaching to the desired stopping position its speed will be slower automatically this requires some change in the control program. This is achievable by changing the time delay of the control pulses. We can also show the interference of microcontroller with temperature sensors for displaying the temperature or provide safety from accident like fire to save human beings and elevator. If any accident like fire occurs an alarm attached to the elevator starts. We can also connect the RTC module with the microcontroller to display 24 hours display in the elevator and a small DC motor represent fan in the elevator for elevator facility purposes. By connecting the DC motor to the elevator doors by increasing the size of elevator we can implement the opening and closing of the doors same in the present model closing and opening of elevator doors are represented by LEDs (green and red).

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