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Design and Implementation of Driving Circuits for DC Motor Control Using 8051

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Abstract— **In the present living conditions people with muscle weakness and partial paralysis of limb are increasing day by day. To perform daily activities for such people an assistive device is necessary, in order to make them perform daily activities like ordinary people. Artificial limbs help amputees get back to their normal functioning to a certain degree. This paper focuses on the control system design for such a device. In this paper a driving circuit to actuate the motorized assistive device is designed, fabricated and controlled in a more simple form with minimum resources and affordable cost. The driving circuit for the supervisory control of DC motors to lock and unlock knee for both limbs during locomotion is designed. The entire operation is made closed loop with the help of feedback circuitry. Here, 8051 microcontroller is used to control the DC series motors for the desired position.**

Keywords - Amputee; DC motors; speed and position control; 8051; gait

I. INTRODUCTION

The population of the elder people is increasing in India, it is to be expected that 10% of people in total population of India having the age sixty five years old and over in 2015. As the people age increases their physical functions degrade. Normal walking requires muscular strength, joint mobility and coordination of the central nervous system. The absence of any of these capabilities can challenge a person's ability to walk. People with partial or complete paralysis of the lower extremity may require orthotic intervention for stability during stance. These individuals can use the developed model which can compensate for severe weakness of the lower limb muscles. The proposed model is simple, cost effective and easily implementable. The main functions of the developed model are to

1. Resist flexion in stance while allowing free knee extension and
2. Permit free knee rotation in flexion and extension when the braced leg is unloaded in swing.

DC motor can be a good choice whenever controlled movement is required due to simplicity, low cost, high reliability, high torque at low speeds, and high accuracy of motion in applications where you need to control rotation angle, speed, position and synchronism. This application presents a driver with capable of controlling acceleration as well as position and speed.

In this paper a driving circuit is designed, developed and controlled in a more implantable form with minimum resources and affordable cost. The driving circuit for the supervisory control of two series motors to lock and unlock the knee during stance phase and swing phase of gait is to be designed. Furthermore, another driving circuit for the proper locomotion of the hips is also to be developed by again using the help of two DC series motors.The driving circuit controls DC motors in both clock/anti-clock wise directions. The simulated results are checked with the hardware setup.

II. SYSTEM DESCRIPTION

The Proposed system can be represented by the following block diagram shown in Fig.1. The entire operation of the blocks is explained briefly as follows with the wired diagram as shown in Fig.2. The input from the power supply unit is 12V which is provided to 8051 microcontroller which in turn generates pulses to drive the DC motors according to the requirement.

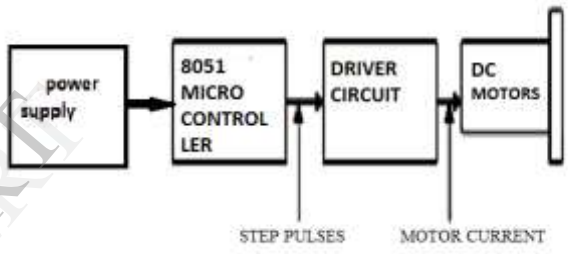

Fig.1 Block diagram of the entire setup

A. Microcontroller 8051

8051 Micro controller is a Harvard architecture, single chip microcontroller (µC) series which was developed by Intel in 1980 for use in embedded systems. Intel's original versions were popular in the 1980s and early 1990s. While Intel no longer manufactures the MCS-51. Several companies also offer MCS-51 derivatives as IP cores for use in FPGAs or ASICs designs. One particularly useful feature of the 8051 core is the inclusion of a Boolean processing engine which allows bit-level Boolean logic operations to be carried out directly and efficiently on select internal registers and select RAM locations. This advantageous feature helped cement the 8051's popularity in industrial control applications because it reduced code size by as much as 30%. Another valued feature is the inclusion of four bank selectable working register sets which greatly reduce the amount of time required to complete an interrupt service routine. With a single instruction the 8051 can switch register banks as opposed to the time consuming task of transferring the critical registers to the stack or designated RAM locations. These registers also allowed the 8051 to quickly perform a context switch which is essential for time sensitive real-time applications.

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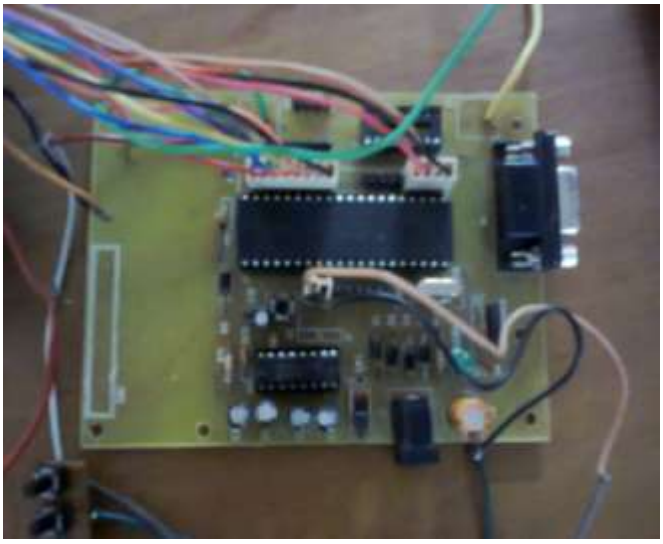

Fig.2 Hardware setup of 8051

B. Driver L293D

The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. This device is designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

When an enable input is high, the associated drivers are enabled and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor application.

The L293D is a quadruple push-pull 4 channel driver capable of delivering 600 mA (1.2 A peak surge) per channel. The L293D is ideal for controlling the forward/reverse/brake motions of small DC motors controlled by a microcontroller such as a PIC or BASIC Stamp.

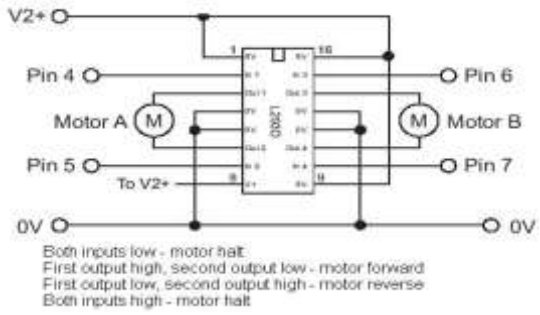

Fig.3 L293D Interfacing with DC Series motor

The L293D is a high voltage, high current four channel driver designed to accept standard TTL logic levels and drive inductive loads (such as relays solenoids, DC and stepping motors) and switching power transistors. The L293D is suitable for use in switching applications at frequencies up to 5 KHz.

C. Dc motors

A DC motor is a mechanically commutated electric motor powered from direct current (DC). The stator is stationary in space by definition and therefore so is its current. The current in the rotor is switched by the commutator to also be stationary in space. This is how the relative angle between the stator and rotor magnetic flux is maintained near 90 degrees, which generates the maximum torque.

DC motors have a rotating armature winding (winding in which a voltage is induced) but non-rotating armature magnetic field and a static field winding (winding that produce the main magnetic flux) or permanent magnet. Different connections of the field and armature winding provide different inherent speed/torque regulation characteristics. The speed of a DC motor can be controlled by changing the voltage applied to the armature or by changing the field current. The introduction of variable resistance in the armature circuit or field circuit allowed speed control. Modern DC motors are often controlled by power electronics systems called DC drives.

D. Switches

The switch which acts as an input to the 8051 microcontroller holds the key to convert the circuit into open loop or closed loop. A binary switch is used in case of the open loop system and a bell type push button is used for the closed loop. The switch is the input to the 8051 microcontroller which gives the binary outputs for the ON and OFF of the dc motor respectively. The switch delivers the pulse to the micro controller and outputs an on-off signal depending on if there is force being applied to it.

Fig.4 ON/OFF Switches

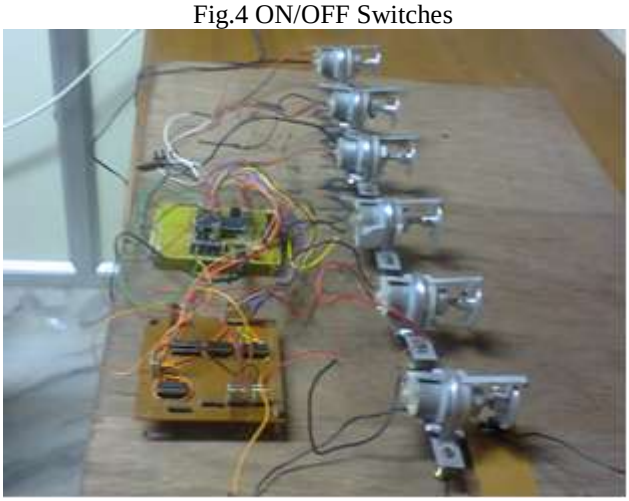

Fig.5 Entire setup of control system drive

III. SIMULATION CIRCUIT AND RESULTS

The proposed control circuit is implemented using software module like Proteus as shown in Fig.5. Proteus is the software for microprocessor simulation, schematic capture, and printed circuit board (PCB) design. For the purpose of coding the software package used is Keil. The µVision IDE from Keil combines project management, make facilities for source code editing, program debugging, and complete simulation in one powerful environment. The output pulses of six dc motors in clockwise and anticlockwise directions are shown respectively.

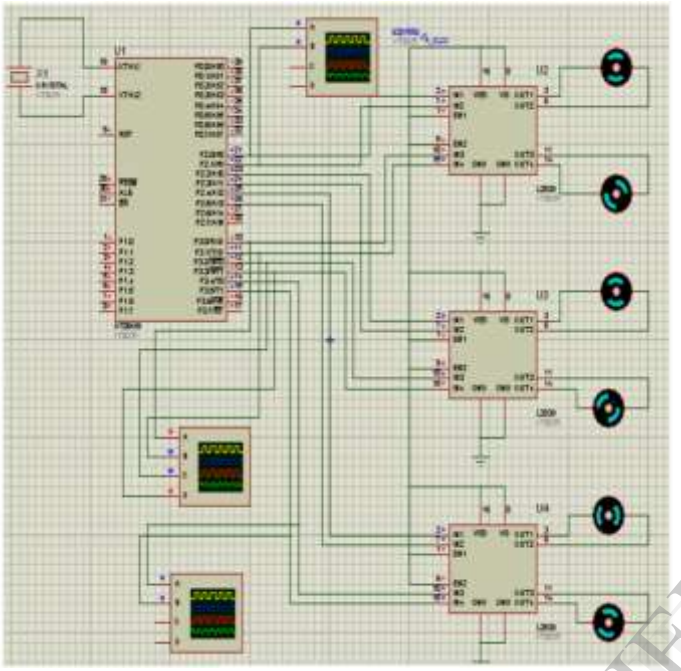

Fig.6 Simulation circuit of the proposed System

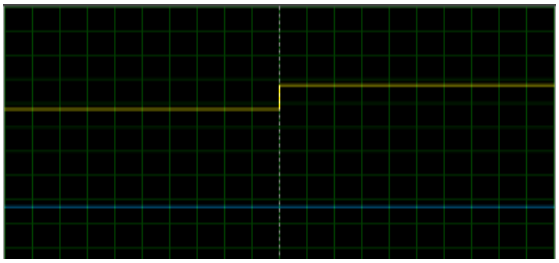

Fig.6(a) Right leg locking motor signal

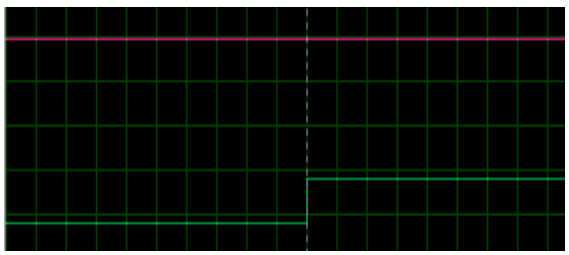

Fig. 6(b) Left leg locking motor signal

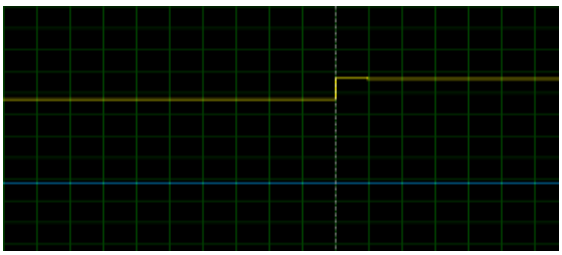

Fig. 6(c) Right knee motor signal

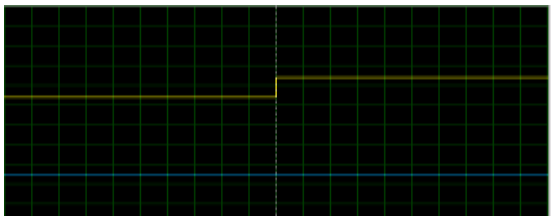

Fig. 6(d) Left knee motor signal

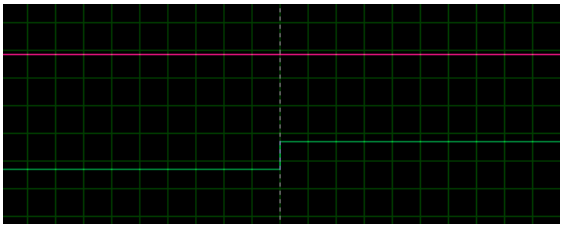

Fig. 6(e) Left hip motor signal

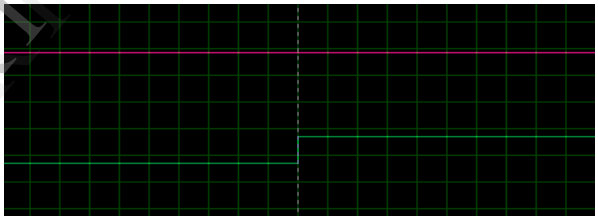

Fig. 6(f) Right hip motor signal

IV. CLOSED LOOP OPERATION

The closed loop operation for the above circuit can be done by replacing the switch with a pressure sensor. Whenever there is any pressure sensed by the sensor, the sensor will give the input to the 8051 microcontroller which in turn rotates the DC series motor clockwise or anti-clockwise direction as per the requirement. For the laboratory purpose, the sensor is been replaced with a push button. The bell type push button gives the signal when the pressure is applied just as the sensor. When the pressure is removed, the motor rotates in the opposite direction.

This approach can be applied to much number of applications. For example, it can be used for the biomedical purposes such as assistive device. The dc motors operation can be used for the locking and unlocking of the knee in assistive device. A foot sensor/bell type switch can be placed under the heel which will send pulse during the stance phase of the gait cycle and locks the knee with the dc motor action and during the swing phase as the pressure decreases on the bell type switch, it sends pulse to the stepper motor which rotates and the knee unlock for the knee to bend during movement of the subject. Thus closed loop control of the above proposed circuit can be obtained where the motors will rotate based on the position or posture.

V.CONCLUSION & FUTURE WORK

In this paper driving circuit of six dc motors is designed which can be applied in many applications. A software code has been written in C to control the position of six dc motors. The program is verified by Keil software. In this paper a driving circuit is designed, developed and controlled in a more implantable form with minimum resources and affordable cost. The proposed mechanism is checked with the hardware developed and result seems to be satisfactory. Future works include making the control system drive closed loop with the help of feedback circuitry which includes optical encoders.

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