

Implementation of Carving Machine Controller Based on L293D

Kalhapure Vrushali Arun

Abstract—A design project of implementation of Carving Machine Controller based on L293D platform is introduced in this paper. ARM (Advanced RISC Machines) is the kernel processors of the control system which takes MATLAB as the software development platform and implements to develop a complete independent system that will automatically carve names or any other design on front surface of thermocol as a material. L293D is selected as motor driving IC of numerical control device and ARM7 as central processing unit of controller. The carving machine with low cost, high speed, good accuracy with easy HMI human machine interaction. It is proved that the control system can effectively improve the efficiency and the machining quality of carving machine.

Index Terms— ARM7 , Carving machine, HMI, MATLAB.

I. INTRODUCTION

In recent years, with the rise of thermocol processing Technology, as a high-tech product based on CNC (Computer Numerical Control) and the combination of mechanical, optical, electronic and computing technology, has got more extensive application. Thermocol carving is a new kind of technology, which appears with the rapid development of the thermocol technique. Patterns and characters can be carved on various materials by the application of thermocol carving, computer graphics and digital image processing [1]. Numerical control carving machine is applied to print, label, woodwork, human faces and figures, walking sticks, relief carvings, kitchen spoons, furniture decorations and many others[5].The system stability and reliability is totally depended on the computers. The control system of thermocol carving machine designed in the paper is based on MATLAB. It takes ARM as embedded hardware platform. Single chip computer is selected as processor of economical numerical control system. They are 8bit, 16bit or 32bit. System is open loop control, stepper motor and Servo motor are used [4]. ARM7 LPC2148 is applied to carving system and the system can realize 2-axis motion control. The system is multi-coordinate, high accuracy and high speed requirement.

II. HARDWARE STRUCTURE

ARM7 series is general-purpose microcontroller NXP Philips. The ARM7TDMI-S is a general purpose 32-bit microprocessor, which offers high performance and very low power consumption.

LPC2148 is one of ARM7 series microcontroller with ARM7TDMI, High capability Flash, inner SRAM and rich peripheral [4]. The microcontroller is used to realize the implementation of interface stepper motor driver, communication with computer and fast response to the stepper motor and servo motor. We are using L293D as stepper motor drivers. It is used for position, speed, and interpolation controls. It had been applied to numerical control machine tool, carving machine, industrial robot etc. L293D contains two inbuilt H-bridge driver circuits. It 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. This device is suitable for use in switching applications at frequencies up to 5 kHz. H-bridge would be preferable where a smaller physical size is needed, high speed switching, low driving voltage, or where the wearing out of mechanical parts is undesirable. To control motor speed we can use pulse width modulation (PWM), applied to the enable pins of L293 driver. Stepper motors provide a means for precise positioning and speed control without the use of feedback sensors. As the stepper changes its direction, carving will take place at the co-ordinate position. MAX232 is a widely known IC used for establishing serial communication bet Microcontrollers and Personal Computers (PC).LPC 2148 has 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate [1]. LPC 2148 is CPU and MATLAB is used as easy HMI. MATLAB sends Commands to LPC2148 by serial port and complete progress of work being carved can be visualized on MATLAB. As showed in Fig. 1 the hardware includes microcontroller, stepper motor, driver circuit and hot tip.

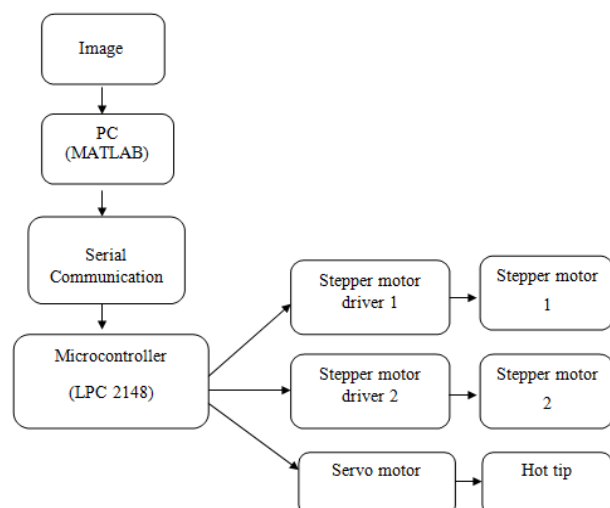


Fig. 1. Generalized block diagram

Manuscript Received on February 2015.

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A. Basic Peripherals

L293D is supplied by 5V power, LPC 2148 core voltage is 1.8V, On-chip peripherals voltage is 3.3V and other peripherals voltage is 5V. So system needs for three sources: 5V, 3.3V, 1.8V. The LPC 2148 is Low power Real-Time Clock (RTC) with independent power and 32 kHz clock input. Development Board can be used to evaluate, demonstrate, applications, prototyping the capabilities of NXP LPC2148 microcontrollers. The LPC2148 microcontroller has 512KB of internal flash and 32+8K RAM, can be clocked up to 60Mhz. LPC2148 features include, 2xUARTs, RTC, 2x10bit ADCs each ADC has multiple channels, 1xDAC, 6XPWM, 2xI2C, 1xSPI, 1XSSP, 2x32-bit TIMERS, FAST I/O support and WDT [4].LPC2148 also supports In System Programming (ISP).

Development Board contains the following items:

- LPC2148/PB/V.1-DEV board
- 12V 1A power adapter
- 1 x Serial cable
- 1 x CD which contains, KEIL evaluation version installer, Flash Magic Installer, schematics, user manual, Programming files for experiments, KEIL workspace for all the experiments which tests all on board peripherals.

Following are the salient features of the board:

- Dimensions: 121 X 87 mm
- Power: DC 9V with power LED On-board linear regulators generate +3.3V/500mA
- ISP and reset switch
- 12.0000 MHz crystal for MCU, 32.368KHz crystal for RTC
- 16X2 character LCD with backlight
- Two RS-232 Interfaces (For direct connection to PC's Serial port)
- User potentiometer connected to ADC interface
- I2C interface with EEPROM, RTC and Seven segment display
- Internal RTC
- On Board Connector for regulated 3V3 output
- On Board Connector for regulated 5V output
- Power Supply Reverse Polarity Protection.

B. Driving Interface

Driving interface circuits are between controller and stepper motor. They realize photoelectric isolating and filtering of I/O signal and amplify the output pulse to drive motor. The output signals such pulse, direction. Signal driving chip L293D is used in output channel. According to different application, different driving device will be selected. RS-232 is used for serial communication ICs. It is interface between PC and microcontroller.

III. DESCRIPTION

It will have many components in it. The Complete system can be divided into two parts. First part consists of a PC along with MATLAB. This part is required to select and control the mechanical grid. Operation starts from MATLAB code. HMI is used to select Object profile in MATLAB code. A GUI can be developed in MATLAB for easy man machine interface. Various buttons will be provided in GUI which when pressed

will send various commands to controller via serial port. Both MATLAB and C programs in controller will be initialized with same baud rate. This will ensure correct communication between PC and controller. RS232 is used for serial communication. Second part consists of microcontroller, stepper motor driver circuit, stepper motors, servo motor and heating tip. As per commands received from PC controller will calculate which stepper motor to move by how much amount. Controller will apply rotating sequence 0001, 0010, 0100,1000 to various stepper motors which will result in rotation of motors and positioning for servo motor. Heating filament near object. As per Object profile feed inside the MATLAB code, MATLAB will keep sending commands to microcontroller and Object will get carved accordingly on the thermacol. Microcontroller to be used is ARM-7. To drive stepper motors, L293D motor driver IC will be used. We will be using stepper because of its property of changing degree of rotation in any direction with precise step angle.

IV. SOFTWARE DESIGN OF CONTROLLER

Embedded C language achieves system software based ARM. We have implemented MATLAB code and MATLAB GUI. We are using Keil software for compiling C code. C code is getting converted into hex file by this software. To load hex file into ARM7 .We are using Philips flash Utility for LPC2148. The Communication baud rate between MATLAB code and ARM7 is set to be 9600bps. MATLAB is a high performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment.

Algorithm:

1. Initialize COM port with baud rate 9600bps.
2. Get image from user interaction.
3. Start operation on user command.
4. If input image is not in binary format then convert it into binary.
5. Read image pixel by pixel.
6. Set i,j as counter for row and column respectively.
7. Position hot carving tip at i, j coordinate on thermacol using stepper motors.
8. Insert tip into thermacol by actuating actuator.
9. Move to next coordinate and repeat this same. Procedure till complete design finishes.

V. RESULT

Fig 2, is the input image to be carved

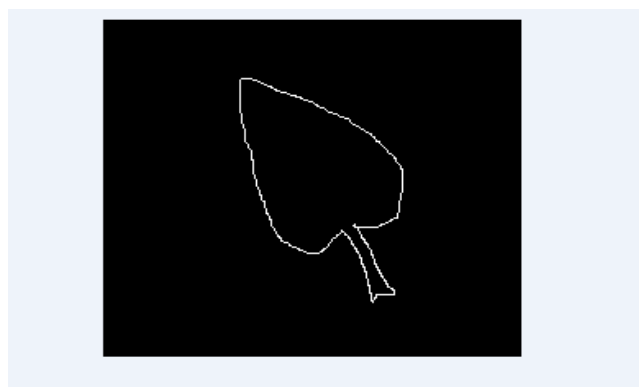


Fig. 2.Input Image

As shown in fig. 3, we have designed a image on MATLAB GUI.



Fig 3. MATLAB GUI.

The machining material is a kind of thermacol with 1.5mm thickness. The duration of the thermacol cutting process is less than 10 minutes. The processing sample is shown in Fig. 4, which is 15cm long and 10cm wide. As shown in the figure, the sample not only reflects the details of the original graphics, but also the machining quality and efficiency is satisfactory.



Fig. 4. Result on thermacol

VI. CONCLUSION

A two-axis winding machine control system based on embedded motion controller is designed in this paper. The two-axis winding machine control system hardware structure is completed. Numeric control carving machine with 2-axis Simultaneous-motioned locates in domestic universal demands. Controller is realized based on embedded microprocessor and motion control technique. Controller is easy to extend, so it is universal. In experiment the controller shows its feature of quick response, high reliability. It's a high performance and low cost option for corporation.

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