

DESIGNING THE SD CARD DEVICE DRIVER FOR FILE MANAGEMENT OF DSP BASED CNC MACHINE

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ABSTRACT: This paper presents a cost effective solution to increase the memory size of the DSP based CNC for Industrial application using DSP TI LaunchXL F28379D Launchpad and SD card. The main objective is to implement file management system for CNC machine using the SD card and hence the increase memory size to hold the large data of .NC and .CNC file. Using Dual core C28x DSP, the operation of the CNC machining tooling operation as well as file management and handling on the SD card can perform simultaneously. This paper will mainly focus on the hardware structure and software program of File handling and file management system implement on the SD card using Launchpad F28379D. This Launchpad is also used for multi axis operation of CNC machine simultaneously. The objective to devise a Low cost CNC machine from increasing demand for flexibility and cutting with respect to edge quality. The system has Dual core C28x microcontroller based embedded system to achieve cost effectiveness and also maintains the required accuracy and reliability for complex shapes as well as file handling and management of the CNC machine. The system uses Embedded C software as Code composer studio.

KEYWORDS: CNC, SD Card, Device driver, FAT32 File system, Launchpad F28379D, CCS, Controlsuite.

INTRODUCTION:

A CNC (computer numerical control) is a microprocessor-based system to store and process the data for the control of slide motions and auxiliary functions of the machine tools. It acts as heart and brain of the CNC machine which enables the operation of various machine members such as slides, spindles, etc. as per the sequence programmed depending on the machining operations. It must control the spindle movement and the speeds. It must feeds the information of machining the job with the various tools and calculates the traversing path of the axes as defined by the inputs. The accuracy of positioning depend on the CNC system's computer control algorithms, the system resolution and the basic mechanical machine accuracy. The control algorithm may cause errors while computing, which will reflect during contouring, but they are very negligible. Though this does not cause point to point positioning error, but when mechanical machine inaccuracy is present, it will result in poorer part accuracy[1,2].

The DSP based controller takes the sensor information (current, voltage, position) as feedback and applies the required control algorithm to drive the PWM signals. The control loop frequency can be anywhere from 10kHz to 40+kHz frequency without missing a beat (true real-time). There are various communication topologies and systems servicing single axis or multi-axis applications (such as robotic arms or CNC machines). It is very challenging to perform the real time control tasks and the communication and application level tasks in a single CPU. The availability of higher density process technologies is enabling the use of Multi-CPU systems[3,4]. For communication and other tasks, a cached memory system is acceptable. However, with the arrival of new high speed (100-200+MBits/sec) DSP microcontroller as well as digital isolation technologies and field oriented motion, it is now possible to perform multi axis and precision operation[2].

The Dual core TMS320F28379D is a powerful 32-bit floating-point dual core microcontroller unit (MCU) designed for advanced closed-loop control applications such as industrial drives and servo motor control, transportation and power line communications. The dual real-time control subsystems are – bit based C28xfloating on-point CPUs, TI's 32 which provide 200 MHz of signal processing performance in each core. The C28x CPUs are further boosted by the new TMU accelerator, which enables fast execution of algorithms with trigonometric operations common in transforms and torque loop calculations; and the VCU accelerator, which reduces the time for complex math operations common in encoded applications[3,5,6].

This CNC machine requires a mass storage of data files which are further processed by the CNC machine. To support this FAT file management system we require SD card to store the data files. This data is processed by the TMS320f28379D processor to execute the various operations such as turning, rolling, grinding, drilling etc. To transfer these files to SD card, SD card and USB module is interfaced with the TMS320f28379D Launchpad. It requires to develop a C Program to implement FAT file handling and management for the SD card. The SD card use SPI mode for communication with C28xMicrocontroller. The Launchpad is interfaced with GLCD and keypad for user interface with CNC machine. To perform multi axis operation of CNC machine, the microcontroller is further interface with stepper motor.

II. SYSTEM OVERVIEW

A. SD Card

Secure Digital (SD) is a flash memory card used in portable devices, including digital cameras and handheld computers. The F28379D microcontroller is communicating to the SD card through the SPI, the first step of the process is to configure the SPI of the device (fig1). The SPISTE(CS) of the F28379D is configured as a GPIO output and pulled high and low manually to meet timing specifications of the SD card. The software flow inside the SD card is shown in Fig2.

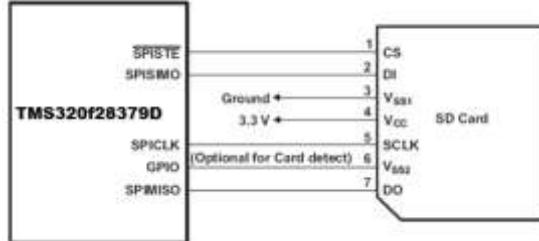


Fig1. Interconnections between TMS320F28379d and SD Card – SPI Mode

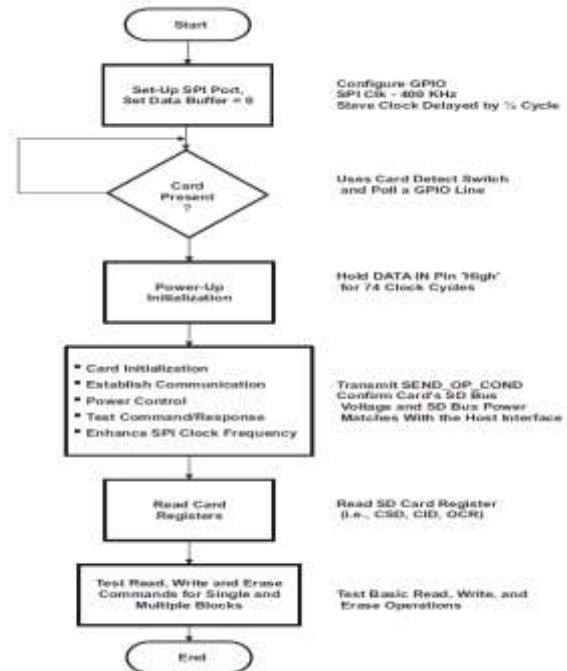


Fig2: Software flow inside SD card.

B. File System

The various file systems for the various devices are such as NTFS, FAT12, UDF, exFAT, FAT16, FAT32. The computer file system architecture is described by File Allocation Table (FAT). This File architecture system is supported by all the compatible devices such as personal computers and many mobile devices as well as various operating systems. From 1981, it is a well-suited format for data exchange between computers and devices of almost any type. The major three Fat File system are: FAT12, FAT16 and FAT32. FAT32 file systems are used for SD Card, USB flash Devices, Memory Cards and various portable embedded devices.

III. SYSTEM DESIGN

Fig.1 shows the overview of the whole system. The Delfino F28379D Launchpad from Texas Instruments (TI) provides a high speed real time application for control systems like CNC machine. This launchpad is intended to provide a well-filtered robust design which is capable of working in most environments. The USB and SD card module can be interface with microcontroller. The .NC or .CNC files are transfer from the USB Flash drive to the SD card and these files are further processed by the CNC machine.

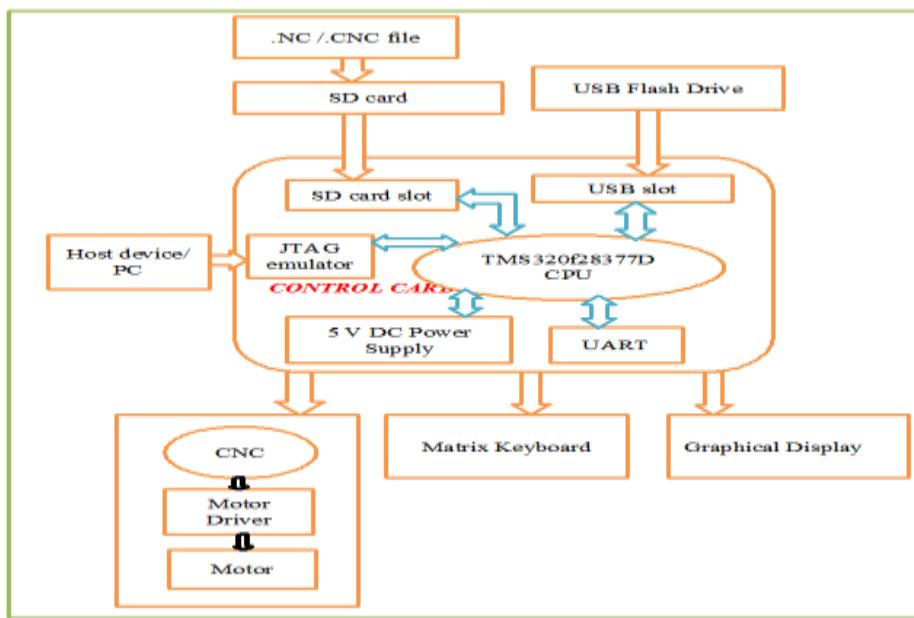


Fig 3: Block Diagram of the Proposed System

The FAT file handling and management is done by the dual core microcontroller using SD card. The Launchpad is also interfaced with the Graphical Display and Keyboard for the user interface. The File handling and management system for the CNC machine is prepared by using SD card interface with the Launchpad using SPI communication. The .kou file must be display on the graphical display which is further processed by microcontroller and converted into tool.U00 and tool1.U00 file. The tool1.U00 file contains G-code and M-code which is send serially from SD card to microcontroller. The Gcode and Mcode is the language which is understands by the CNC machine and it decides the operation of the CNC machine. The operation of the file transfer from USB flash drive to the SD card is carried out with help of keyboard. The processing of the file is done using the FAT32 file system which includes the commands like file read, file write, create new file, file cat, file copy, file delete etc. The parameters of the CNC system will be displayed on graphical display.

A. Hardware Design

The dual real-time control subsystems are based on TI's 32-bit C28x floating-point CPUs, which provide 200 MHz of signal processing performance in each core. For the fast execution of algorithms with trigonometric operations common in transforms and torque loop calculations it uses TMU accelerator and the VCU accelerator, which reduces the time for complex math operations common in encoded applications(fig 4). The F28379D microcontroller has two CLA real-time control co-processors. The CLA is an independent 32-bit floating-point processor that runs at the same speed as the main CPU. It helps for parallel processing capabilities and hence it is effectively double the computational performance of a real-time control system. An independent 4 16-bit ADCs will help to efficient and precise management of multiple analog signals, which ultimately boosts system throughput. To enable isolated current shunt measurements it uses the sigma-delta filter module (SDFM) works along with the sigma-delta modulator. The Comparator Subsystem (CMPSS) with windowed comparators allows for protection of power stages when current limit conditions are exceeded or not met. Other analog and control peripherals include DACs, PWMs, eCAPs, eQEPs, and other peripherals[5,6]. The device has peripherals such as EMIFs, CAN modules and a new uPP interface extend the connectivity of the F28379D. The uPP interface is a new feature of the C2000 MCUs and supports high-speed parallel connection to FPGAs or other processors with similar uPP interfaces. It has a USB 2.0 port with MAC and PHY allows users to easily add universal serial bus (USB) connectivity to their application. The Launchpad is interface with the SD Card, Keypad and Graphical Display.



Fig 4. F28379D Launchpad



Fig 5: Command execution using Fat32 File system

B. Software Design

Here we are designing the device driver for the peripheral device SD card which is interface with Launchpad TMS320F28379D Microcontroller. The Text file in the Format of ASCII is selected from the SD card and then further processed according to the algorithm as follows:

1. Select .txt or .nc or .U00 file in the ASCII format.
 2. For the tool processing, choose the acceleration time, maximum feed and maximum plunge for the tool processing.
 3. By calculating feed and acceleration rate create the tool.U00 and tool1.U00 files
 4. To create nos.abc file which shows the line no. of G-code which are changed due to calculations.
 5. To generate the .kou file with change in feed value and Emin distance for tool processing.

This processing and coding is done by using C software Texas Instruments (TI) Code Composer Studio(CCS). It includes compilers for each of TI's device families, source code editor, project build environment, debugger, profiler, simulators, real-time operating system and many other features needed to develop an embedded system. The FAT32 file system is designed for SD card using dual core F28379D processor. Using FAT32 files from SD card can be read, write, copied or newly created according to algorithm as shown in fig. 5

IV. CONCLUSION

In this paper the design and realization of a DSP microcontroller based embedded three dimensional CNC machine was presented. The TI TMS320F28379D Processor is Dual Core processor along with two additional CLA units so that high computation required for the CNC machine can be easily done. The TI TMS320F28379D Processor is cost effective solution for real time operation of the CNC machine with high operating speed of 200MHz. The Fat file management system can be easily implemented on SD Card using DSP microcontroller. The device driver for SD Card is implemented using C programming in the Code Composer Studio. The interfacing of the Keypad and Graphical display to the Launchpad is provide to access for user interface.

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