移植FATFS文件系统存取SD Card

NuMicro® 32 位系列微控制器范例代码介绍

文件信息

代码简述	本范例代码移植 FATFS 文件文件系统，来存取 SD 卡
BSP 版本	NUC230/240 Series BSP v3.01.002
开发平台	NUC240VE3AN NuEdu Board V2.0 + NuEdu-Advance02 V1.1

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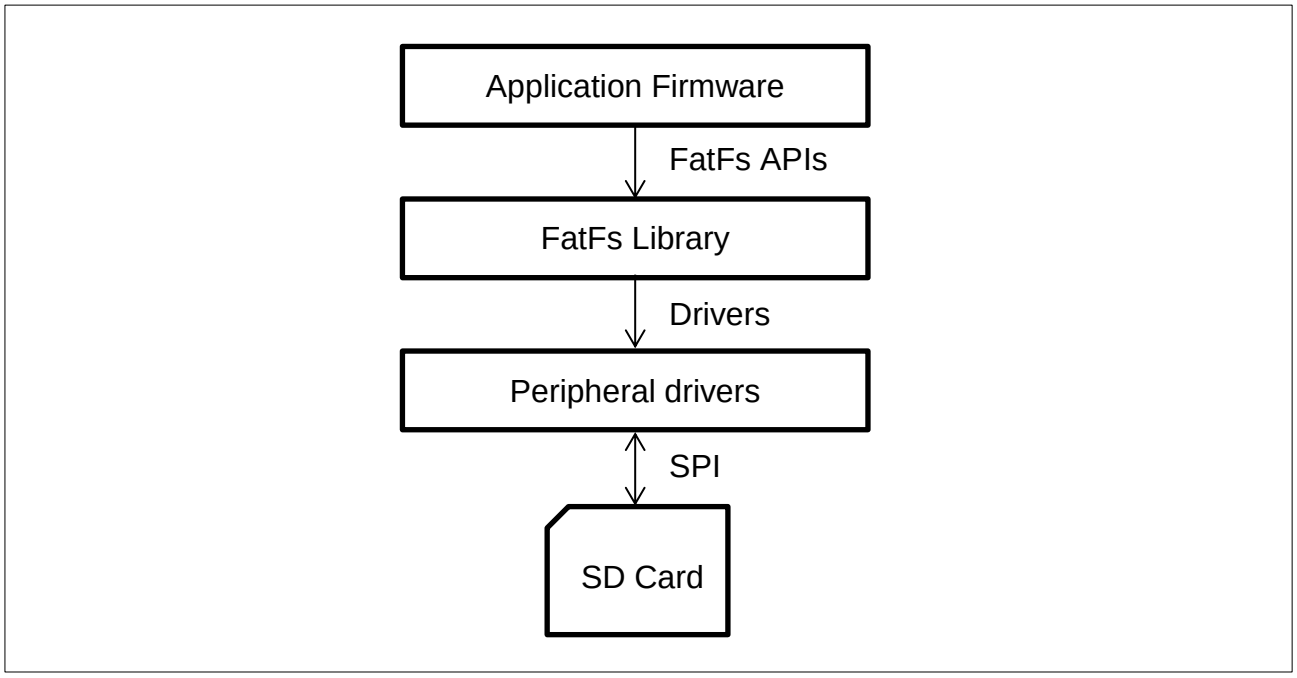
1 功能介绍

1.1 简介

SD 记忆卡系统支持两种通讯模式：SD 模式和 SPI 模式。此范例使用 SPI 模式和 SD 卡通讯，和读写 SD 卡 FAT 文件系统上的档案。SD 卡的文件系统层是采用第三方的 FatFs 函式库，而 FatFs 为一个专为小型嵌入式系统设计的通用 FAT 文件系统模块。

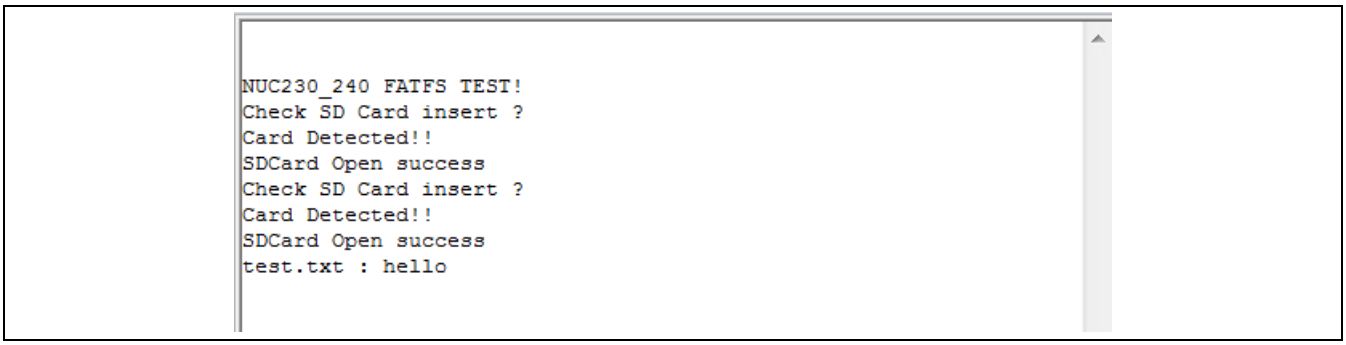
1.2 原理

SD 卡透过 SPI 模式存取的架构显示如下图：基本的存取流程为应用端韧体呼叫 FatFs APIs 读写档案，接着 FatFs APIs 呼叫 SPI 驱动接口来和 SD 卡接收和传送数据。



1.3 执行结果

范例执行结果，可进入Keil MDK 侦错模式，打开UART#1窗口，即可看到输出讯息如下。



2 代码介绍

FatFs 函式库提供文件系统的函式，下表列出此范例会使用到的函式如下：

FUNCTION NAME	FUNCTION DESCRIPTION
f_open	Open or create a file
f_close	Close an open file object
f_read	Read data from the file
f_write	Write data to the file
f_lseek	Move file pointer of the file object
f_mount	Mount/Unmount a logical drive

有五个 FatFs 接口程序需要实作，其档案在 EC_NUC230_240_FATFS_SDCard_V1.0\SampleCode\ExampleCode\NUC230_240_FATFS_SDCard\diskio.c。

FUNCTION NAME	FUNCTION DESCRIPTION
disk_initialize	Initialize device
disk_status	Get device status
disk_read	Read sector(s)
disk_write	Write sector(s)
disk_ioctl	Control device dependent functions

有些 FatFs 接口程序需要呼叫 SD 卡的驱动程序来存取 SD 卡，如下表所列。这些 SD 卡驱动程序以 SPI 实作在 sdcard.c 档案，sdcard.c 的路径位于 EC_NUC230_240_FATFS_SDCard_V1.0\SampleCode\ExampleCode\NUC230_240_FATFS_SDCard 目录下。

FUNCTION NAME	FUNCTION DESCRIPTION
SDCARD_Open	Open GPIO function and initial SD card
SDCARD_Close	Close SD card
MMC_Command_Exec	Send SDCARD CMD and Receive Response
GetLogicSector	Get logic sector size
SDCARD_GetCardSize	Get card total sector after SDCARD is opened
SpiRead	Get data from SD card
SpiWrite	Store data into SD card

范例程序如下所示。在 SYS_Init() 中开启晶振和 PLL，打开 UART0 和 SPI1 模块并选择其时钟源，设置所有使用脚位的 MFP 功能。

设置脚位的 MFP 功能如下：

- PB.0 设置为 UART0_RXD
- PB.1 设置为 UART0_TXD
- PC.9 设置为 SPI1_CLK
- PC.10 设置为 SPI1_MISO
- PC.11 设置为 SPI1_MOSI

```
void SYS_Init(void)
{
    /* Unlock protected registers */
    SYS_UnlockReg();

    /*---------------------------------------------------------------------------------------------------------*/
    /* Init System Clock                                                                                       */
    /*---------------------------------------------------------------------------------------------------------*/

    /* Enable Internal RC 22.1184MHz clock */
    CLK_EnableXtalRC(CLK_PWRCON_OSC22M_EN_Msk);

    /* Waiting for Internal RC 22M clock ready */
    CLK_WaitClockReady(CLK_CLKSTATUS_OSC22M_STB_Msk);

    /* Switch HCLK clock source to Internal RC and HCLK source divide 1 */
    CLK_SetHCLK(CLK_CLKSEL0_HCLK_S_HIRC, CLK_CLKDIV_HCLK(1));

    /* Enable external XTAL 12MHz clock */
    CLK_EnableXtalRC(CLK_PWRCON_XTL12M_EN_Msk);

    /* Waiting for external XTAL clock ready */
    CLK_WaitClockReady(CLK_CLKSTATUS_XTL12M_STB_Msk);

    /* Set core clock as PLL_CLOCK from PLL */
    CLK_SetCoreClock(PLL_CLOCK);

    /* Enable UART module clock */
    CLK_EnableModuleClock(UART0_MODULE);

    /* Select UART module clock source */
    CLK_SetModuleClock(UART0_MODULE, CLK_CLKSEL1_UART_S_PLL, CLK_CLKDIV_UART(1));

    /* Enable SPI1 peripheral clock */
```

```
    CLK_EnableModuleClock(SPI1_MODULE);

    /* Select HCLK as the clock source of SPI1 */
    CLK_SetModuleClock(SPI1_MODULE, CLK_CLKSEL1_SPI1_S_HCLK, MODULE_NoMsk);

    /*---------------------------------------------------------------------------------------*/
    /* Init I/O Multi-function                                                               */
    /*---------------------------------------------------------------------------------------*/

    /* Set GPB multi-function pins for UART0 RXD and TXD */
    SYS->GPB_MFP &= ~(SYS_GPB_MFP_PB0_Msk | SYS_GPB_MFP_PB1_Msk);
    SYS->GPB_MFP |= SYS_GPB_MFP_PB0_UART0_RXD | SYS_GPB_MFP_PB1_UART0_TXD;

    /* Setup SPI1 multi-function pins */
    #ifdef DEFINE_SS
    SYS->GPC_MFP = SYS_GPC_MFP_PC9_SPI1_CLK | SYS_GPC_MFP_PC10_SPI1_MISO0 |
SYS_GPC_MFP_PC11_SPI1_MOSI0;
    SYS->ALT_MFP = SYS_ALT_MFP_PC9_SPI1_CLK | SYS_ALT_MFP_PC10_SPI1_MISO0 |
SYS_ALT_MFP_PC11_SPI1_MOSI0;
    #else
    SYS->GPC_MFP = SYS_GPC_MFP_PC8_SPI1_SS0 | SYS_GPC_MFP_PC9_SPI1_CLK |
SYS_GPC_MFP_PC10_SPI1_MISO0 | SYS_GPC_MFP_PC11_SPI1_MOSI0;
    SYS->ALT_MFP = SYS_ALT_MFP_PC8_SPI1_SS0 | SYS_ALT_MFP_PC9_SPI1_CLK |
SYS_ALT_MFP_PC10_SPI1_MISO0 | SYS_ALT_MFP_PC11_SPI1_MOSI0;
    #endif

    /* Lock protected registers */
    SYS_LockReg();
}
```

在main()中呼叫disk_initialize()来初始化磁盘、呼叫f_mount()来挂载一个逻辑磁盘、呼叫f_open()来开启档案、呼叫f_write()来写入数据、呼叫f_read()来读取数据、呼叫f_close()来关闭档案。

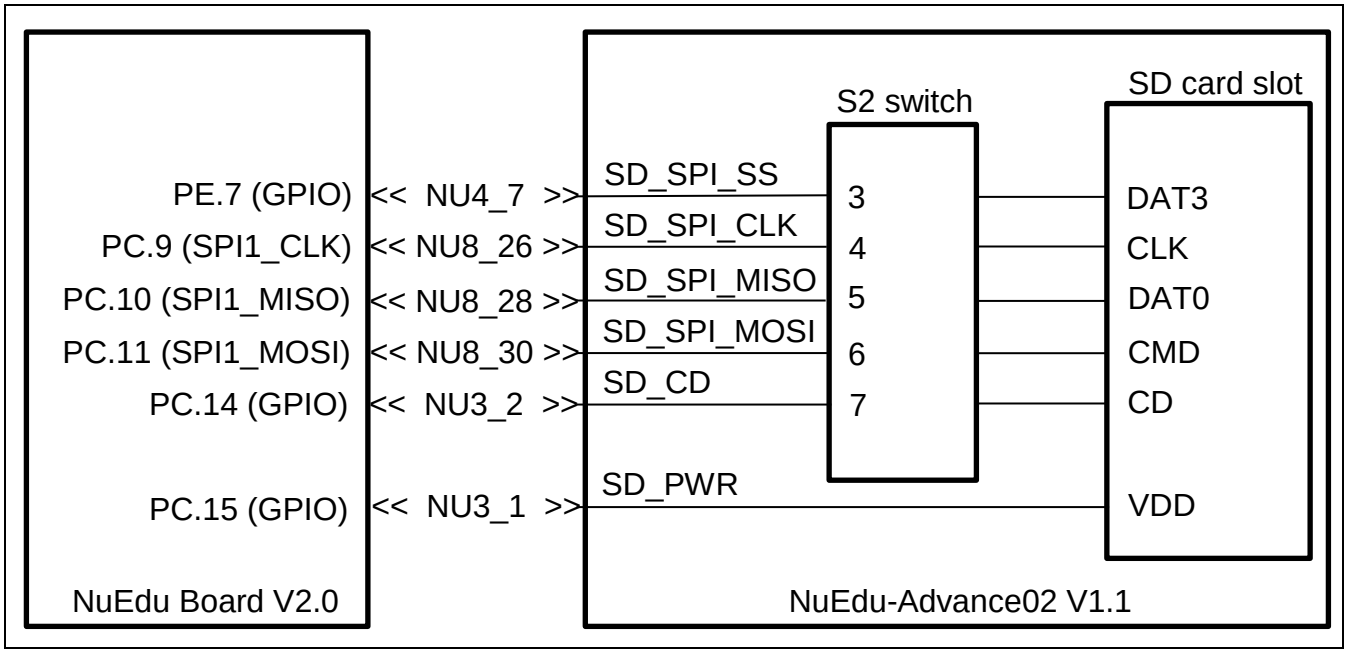
```
int32_t main(void)
{
    uint32_t u32Count;
    FIL file;       /* File objects */
    char achBufRead[512];
    FRESULT res;

    /* Init System, IP clock and multi-function I/O */
    SYS_Init();
```

```
/* Init UART to 115200-8n1 for print message */
UART_Open(UART0, 115200);

printf("\n\nNUC230_240 FATFS TEST!\n");

/* SD card initializetion */
if (disk_initialize(0) != RES_OK)
{
    printf("SDCard initialization failed\n");
}

disk_read(0, g_aBuff, 2, 1);

/* Mount a logical drive */
res = f_mount(&g_aFatFs[0], g_aSD_Path, 1);
if (res)
{
    put_rc(res);
    printf("[ERROR] Mount file system is failed!\n");
    while(1);
}

/* Open test.txt file */
f_open(&file, "test.txt", FA_OPEN_ALWAYS | FA_READ |FA_WRITE);

/* Move the file pointer to end of file */
f_lseek(&file, file.obj.objsize);

/* Write hello text into test.txt */
f_write(&file, "hello ", 6, &u32Count);

/* Move the file pointer to start of file */
f_lseek(&file, 0);

/* Read content in test.txt */
f_read(&file, achBufRead, file.obj.objsize, &u32Count);

printf("test.txt : %s \n", achBufRead);

/* Close file */
```

```
    f_close(&file);

    while(1);
}
```

3 软件与硬件环境

- 软件环境
  - BSP 版本
    - NUC230/240 Series BSP v3.01.002
  - IDE 版本
    - Keil uVersion 5.26
- 硬件环境
  - 电路组件
    - NUC240VE3AN NuEdu Board V2.0
    - NuEdu-Advance02 V1.1(SD 卡接口透过 SPI, S2 开关上的 1、2、3、4、5、6、7 设为 ON)
  - 示意图



  - PE.7: GPIO 脚位，设成 output 模式， 为 SPI 的从选择脚位，连接到 SD 卡槽的 DAT3。
  - PC.9: SPI1_CLK 脚位，连接到 SD 卡槽的 CLK。
  - PC.10: SPI1_MISO 脚位，连接到 SD 卡槽的 DAT0。
  - PC.11: SPI1_MOSI 脚位，连接到 SD 卡槽的 CMD。
  - PC.14: GPIO 脚位，设成 input 模式，为卡侦测脚位，连接到 SD 卡槽的 CD。
  - PC.15: GPIO 脚位，设成 output 模式，连接到 SD 卡槽的 VDD。

4 目录信息

- EC_ NUC230_240_FATFS_SDCard_V1.00
  - Library — Sample code header and source files
    - CMSIS — Cortex® Microcontroller Software Interface Standard (CMSIS) by Arm® Corp.
    - Device — CMSIS compliant device header file
    - StdDriver — All peripheral driver header and source files
  - SampleCode
    - ExampleCode — Source file of example code
  - ThirdParty
    - FatFs — A generic FAT file system module for small embedded systems. Its official website is: http://elm-chan.org/fsw/ff/00index_e.html.

5 如何执行范例程序

1. 根据目录信息章节进入 ExampleCode 路径中的 KEIL 文件夹，双击 NUC230_240_FATFS_SDCard.uvproj。
2. 进入编译模式接口
   a. 编译
   b. 下载代码至内存
   c. 进入 / 离开除错模式
3. 进入除错模式接口
   a. 执行代码

6 修订纪录

Date	Revision	Description
Aug. 21, 2019	1.00	1. 初始发布.

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