移植FATFS文件系統存取SD Card

NuMicro® 32 位系列微控制器範例代碼介紹

文件資訊

代碼簡述	本範例代碼移植 FATFS 文件檔案系統，來存取 SD 卡
BSP 版本	NUC230/240 Series BSP v3.01.002
開發平台	NUC240VE3AN NuEdu Board V2.0 + NuEdu-Advance02 V1.1

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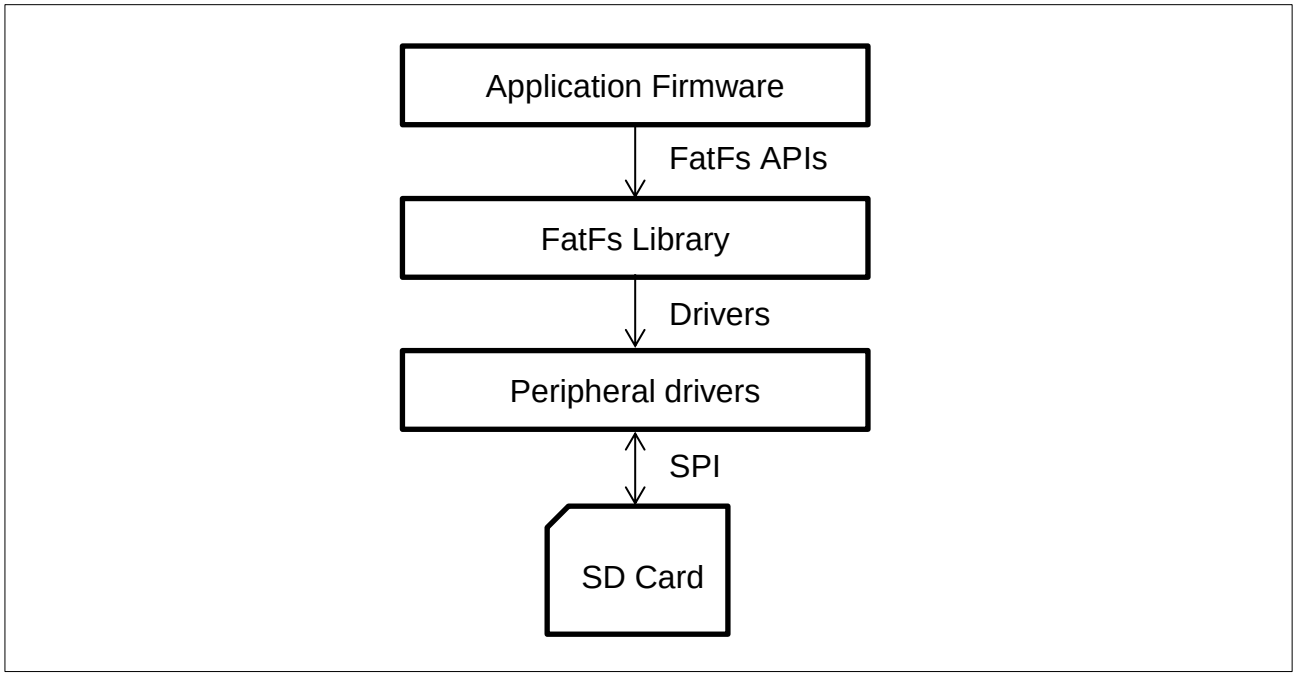
1 功能介紹

1.1 簡介

SD 記憶卡系統支援兩種通訊模式：SD 模式和 SPI 模式。此範例使用 SPI 模式和 SD 卡通訊，和讀寫 SD 卡 FAT 文件系統上的檔案。SD 卡的文件系統層是採用第三方的 FatFs 函式庫，而 FatFs 為一個專為小型嵌入式系統設計的通用 FAT 文件系統模組。

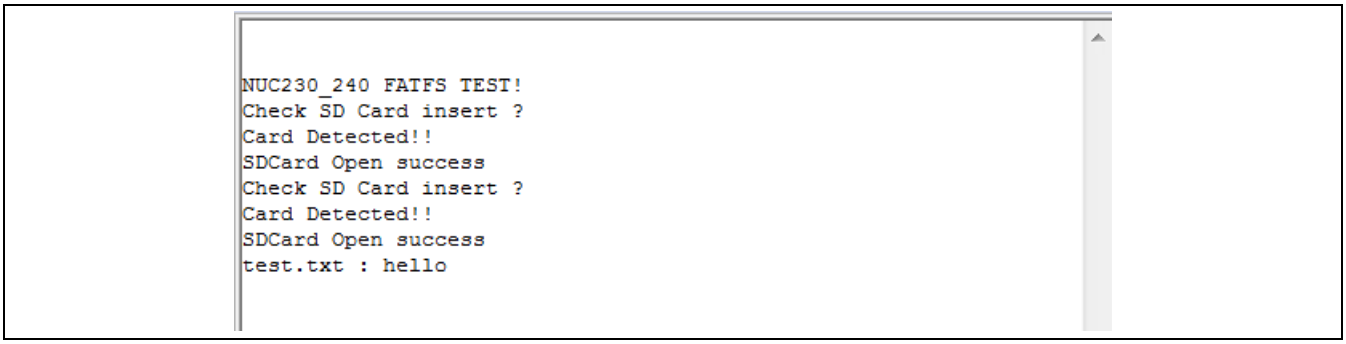
1.2 原理

SD 卡透過 SPI 模式存取的架構顯示如下圖：基本的存取流程為應用端韌體呼叫 FatFs APIs 讀寫檔案，接著 FatFs APIs 呼叫 SPI 驅動介面來和 SD 卡接收和傳送資料。



1.3 執行結果

範例執行結果，可進入Keil MDK 偵錯模式，打開UART#1視窗，即可看到輸出訊息如下。



2 代碼介紹

FatFs 函式庫提供文件系統的函式，下表列出此範例會使用到的函式如下：

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

有五個 FatFs 介面程式需要實作，其檔案在 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 介面程式需要呼叫 SD 卡的驅動程式來存取 SD 卡，如下表所列。這些 SD 卡驅動程式以 SPI 實作在 sdcard.c 檔案，sdcard.c 的路徑位於 EC_NUC230_240_FATFS_SDCard_V1.0\SampleCode\ExampleCode\NUC230_240_FATFS_SDCard 目錄下。

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

範例程式如下所示。在 SYS_Init() 中開啟晶振和 PLL，打開 UART0 和 SPI1 模組並選擇其時鐘源，設置所有使用腳位的 MFP 功能。

設置腳位的 MFP 功能如下：

- PB.0 設置為 UART0_RXD
- PB.1 設置為 UART0_TXD
- PC.9 設置為 SPI1_CLK
- PC.10 設置為 SPI1_MISO
- PC.11 設置為 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();
}
```

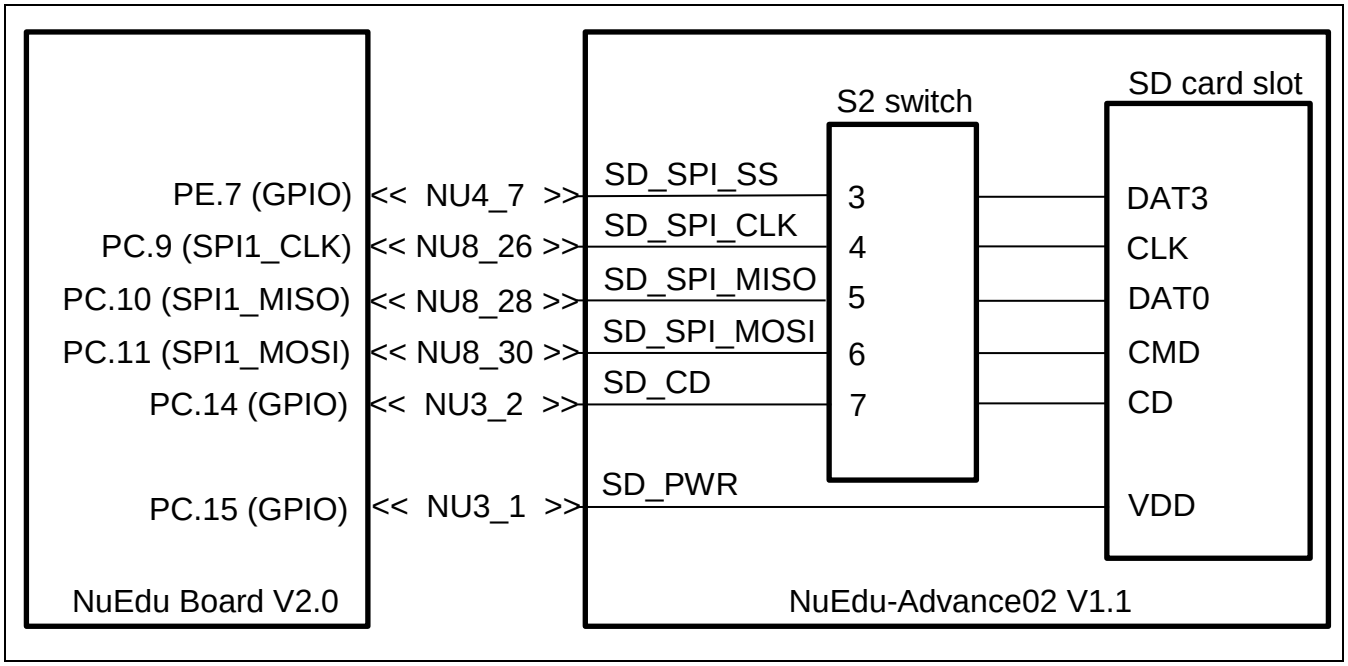
在main()中呼叫disk_initialize()來初始化磁碟、呼叫f_mount()來掛載一個邏輯磁碟、呼叫f_open()來開啟檔案、呼叫f_write()來寫入資料、呼叫f_read()來讀取資料、呼叫f_close()來關閉檔案。

```
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 軟體與硬體環境

- **軟體環境**
  - BSP 版本
    - NUC230/240 Series BSP v3.01.002
  - IDE 版本
    - Keil uVersion 5.26
- **硬體環境**
  - 電路元件
    - NUC240VE3AN NuEdu Board V2.0
    - NuEdu-Advance02 V1.1(SD 卡介面透過 SPI, S2 開關上的 1、2、3、4、5、6、7 設為 ON)
  - 示意圖



- PE.7: GPIO 腳位，設成 output 模式， 為 SPI 的從選擇腳位，連接到 SD 卡槽的 DAT3。
- PC.9: SPI1_CLK 腳位，連接到 SD 卡槽的 CLK。
- PC.10: SPI1_MISO 腳位，連接到 SD 卡槽的 DAT0。
- PC.11: SPI1_MOSI 腳位，連接到 SD 卡槽的 CMD。
- PC.14: GPIO 腳位，設成 input 模式，為卡偵測腳位，連接到 SD 卡槽的 CD。
- PC.15: GPIO 腳位，設成 output 模式，連接到 SD 卡槽的 VDD。

4 目錄資訊

- 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 如何執行範例程式

1. 根據目錄資訊章節進入 ExampleCode 路徑中的 KEIL 資料夾，雙擊 NUC230_240_FATFS_SDCard.uvproj。
2. 進入編譯模式介面
   a. 編譯
   b. 下載代碼至記憶體
   c. 進入 / 離開除錯模式
3. 進入除錯模式介面
   a. 執行代碼

6 修訂紀錄

Date	Revision	Description
Aug. 21, 2019	1.00	1. 初始發布.

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