NUC505從內部SPI flash撥放MP3檔

NuMicro® 32 位系列微控制器範例代碼介紹

文件資訊

代碼簡述	本範例代碼從NUC505內部SPI flash讀取MP3檔案撥放
BSP 版本	NUC505 Series BSP CMSIS V3.02.000
開發平台	NuTiny-EVB-NUC505 V1.6

The information described in this document is the exclusive intellectual property of Nuvoton Technology Corporation and shall not be reproduced without permission from Nuvoton.

Nuvoton is providing this document only for reference purposes of NuMicro microcontroller based system design. Nuvoton assumes no responsibility for errors or omissions.

All data and specifications are subject to change without notice.

For additional information or questions, please contact: Nuvoton Technology Corporation.

www.nuvoton.com

1 功能介紹

1.1 簡介

範例程式中，NUC505使用內部音訊解碼器，讀取存在內部SPI flash的MP3檔並且撥放。使用者需先燒錄MP3檔至內部SPI flash，並從config.h檔中的MP3_address去指定MP3檔儲存位置以及用MP3File_Size去指定MP3檔案大小。請注意MP3檔案不可超過NUC505記憶體位置。程式會先搜尋MP3檔頭，來驗證儲存是否為MP3檔。

MP3檔案存放地址範圍	MP3檔案位置參數	MP3檔案大小參數
0x11000~0x1F_FFFF	MP3_address	MP3File_Size

NUC505支援單/雙聲道，資料長度為16 bits格式，取樣率為8k, 11025, 12k, 16k, 22050, 24k, 32k, 44100和48k，程式碼會自動依照不同取樣率設定APLL數值。

1.2 執行結果

執行後會打印出以下資訊

```
Relocate vector table in SRAM (0x20000000) for fast interrupt handling, size = 0xbc.
+------------------------------------------------------------+
|         Play MP3 from internal Flash Sample Code           |
+------------------------------------------------------------+
  Please store MP3 first in the internal Flash.
  MP3 storage location cannot exceed flash size
  NOTE: Need head-phone.

MP3 pre-stored in internal SPI Flash address from 0x00011000
168 byte(s) to the 1st frame.
====[MP3 Info]======
FileSize = 416 KB
SampleRate = 44100
BitRate = 320000
Channel = 2
=====================

Configure Internal CODEC ...[OK]
Start playing ...
Exit MP3
Stop ...
```

2 代碼介紹

首先在main.c中對NUC505做初始化設定，並且把程式碼放入SRAM中執行以增加其執行速度，根據MP3_address所設定位置讀取MP3檔撥放。

```
int32_t main(void)
{
    /* Init System, IP clock and multi-function I/O */
    SYS_Init();

    /* Init UART0 to 115200-8n1 for print message */
    UART0_Init();

    /* Relocate vector table in SRAM for fast interrupt handling. */
    {
        extern uint32_t __Vectors[];
        extern uint32_t __Vectors_Size[];
        extern uint32_t Image$$ER_VECTOR2$$ZI$$Base[];

        printf("Relocate vector table in SRAM (0x%08X) for fast interrupt handling, size =
0x%x.\n", Image$$ER_VECTOR2$$ZI$$Base, (unsigned int) __Vectors_Size);
        memcpy((void *) Image$$ER_VECTOR2$$ZI$$Base, (void *) __Vectors, (unsigned int)
__Vectors_Size);
        SCB->VTOR = (uint32_t) Image$$ER_VECTOR2$$ZI$$Base;
    }
    /* Init I2S */
    I2S_Init();

    printf("+------------------------------------------------------------+\n");
    printf("|         Play MP3 from internal Flash Sample Code           |\n");
    printf("+------------------------------------------------------------+\n");
    printf("  Please store MP3 first in the internal Flash.\n");
    printf("  MP3 storage location cannot exceed flash size\n");
    printf("  NOTE: Need head-phone. \n\n");

    /* Play MP3 from internal flash at MP3_address*/
    MP3Player(MP3_address);

    while (1);
}
```

在MP3Player(MP3_address)函式中，程式會先搜尋MP3檔頭，來驗證儲存是否為MP3檔，並且讀取MP3檔相關資訊，並根據取樣率對APLL做設定。

```
    /* Parse MP3 header */
    i32Offset = MP3_ParseHeaderInfo(MP3StartAddr);

    if (i32Offset < 0)
        return;
    else {
        /* Check if the MP3 SamplRate frequency is 11025 multiples */
        if (audioInfo.mp3SampleRate % 11025) {
            /* APLL is 49152031Hz for 12k, 16k, 24k, 32k, 48k, and 96k sampling rate */
            CLK_SET_APLL(CLK_APLL_49152031);
            if (audioInfo.mp3SampleRate == 8000)
                CLK_SetModuleClock(I2S_MODULE, CLK_I2S_SRC_APLL, 1);
        }
```

MP3經過解碼之後使用Ping-pong buffer機制撥放，其流程如下：

```
        /* Decode finished, try to copy pcm data to audio buffer */
        if (audioInfo.mp3Playing) {
            /* If next buffer is still full (playing), wait until it's empty */
            if (aPCMBuffer_Full[u8PCMBufferTargetIdx] == 1)
                while (aPCMBuffer_Full[u8PCMBufferTargetIdx]);
        } else {
            /* All buffers are full, wait */
            if ((aPCMBuffer_Full[0] == 1) && (aPCMBuffer_Full[1] == 1)) {
                /* Start to play */
                StartPlay();
                while (aPCMBuffer_Full[0]);
            }
        }
        for (i = 0; i < (int)Synth.pcm.length; i++) {
            /* Get the left/right samples */
            sampleL = Synth.pcm.samples[0][i];
            sampleR = Synth.pcm.samples[1][i];
            //FIXME mono application
            //if ( audioInfo.mp3Channel )
            //    sampleR = sampleL;

            /* Fill PCM data to I2S(PDMA) buffer */
            aPCMBuffer[u8PCMBufferTargetIdx][pcmbuf_idx++] = sampleR | (sampleL << 16);
```

```
            /* Need change buffer ? */
            if (pcmbuf_idx == PCM_BUFFER_SIZE) {
                NVIC_DisableIRQ(I2S_IRQn);
                /* Set buffer full flag */
                aPCMBuffer_Full[u8PCMBufferTargetIdx] = 1;
                NVIC_EnableIRQ(I2S_IRQn);
                u8PCMBufferTargetIdx ^= 1;
                pcmbuf_idx = 0;
                //printf("change to ==>%d ..\n", u8PCMBufferTargetIdx);
            }
        }
```

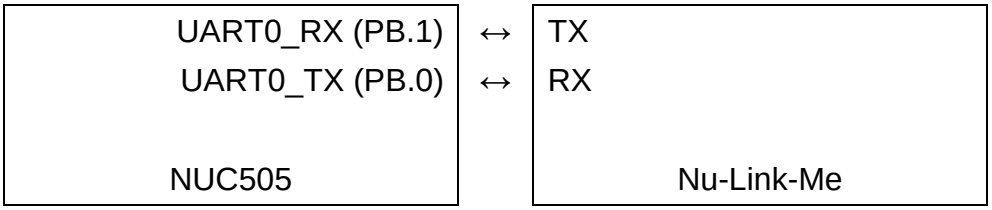
在nuc505_isr.c，當資料傳送完畢時清除緩衝區(buffer)滿溢旗標

```
void I2S_IRQHandler(void)
{
    uint32_t u32I2SIntFlag;


    /* Check interruput flag */
    u32I2SIntFlag = I2S_GET_INT_FLAG(I2S, I2S_STATUS_TDMATIF_Msk |
I2S_STATUS_TDMAEIF_Msk);


    if (u32I2SIntFlag & I2S_STATUS_TDMATIF_Msk) {
        I2S_CLR_INT_FLAG(I2S, I2S_STATUS_TDMATIF_Msk);


        /* Buffer 0 transfer completed, clear buffer full flag */
        aPCMBuffer_Full[0] = 0;
    } else if (u32I2SIntFlag & I2S_STATUS_TDMAEIF_Msk) {
        I2S_CLR_INT_FLAG(I2S, I2S_STATUS_TDMAEIF_Msk);
        /* Buffer 1 transfer completed, clear buffer full flag */
        aPCMBuffer_Full[1] = 0;
    }
}
```

3 軟體與硬體環境

- **軟體環境**
  - BSP 版本
    - NUC505 Series BSP CMSIS V3.02.000
  - IDE 版本
    - Keil uVersion 5.26
- **硬體環境**
  - 電路元件
    - NuTiny-EVB-NUC505 V1.6
    - 3.5 mm 接頭耳機
  - 示意圖

使用 3.5 mm 接頭耳機連接板上的 HP OUT 底座，並透過 NUC505 的 UART0_RX(PB.1)、UART0_TX(PB.0)連接至 Nu-Link Me，打印訊息。設置終端機的 COM Port 與 Baud，COM Port 的編號可在裝置管理員中找到「NuBridge Virtual Com Port (COMX)」，Baud 設置為 115200。



4 目錄資訊

- EC_NUC505_MP3PlayerSPIFlash_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.
    - LibMAD — A MPEG audio decoder library which currently supports MPEG-1 and the MPEG-2 extension to lower sampling frequencies, as well as the de facto MPEG 2.5 format. All three audio layers — Layer I, Layer II, and Layer III (i.e. MP3) are fully implemented. This library is distributed under GPL license. Please contact Underbit Technologies (http://www.underbit.com/) for the commercial license

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 MP3PlayerSPIFlash.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
Jul. 03, 2019	1.00	1. 初始發布.

Important Notice

Nuvoton Products are neither intended nor warranted for usage in systems or equipment, any malfunction or failure of which may cause loss of human life, bodily injury or severe property damage. Such applications are deemed, "Insecure Usage".

Insecure usage includes, but is not limited to: equipment for surgical implementation, atomic energy control instruments, airplane or spaceship instruments, the control or operation of dynamic, brake or safety systems designed for vehicular use, traffic signal instruments, all types of safety devices, and other applications intended to support or sustain life.

All Insecure Usage shall be made at customer's risk, and in the event that third parties lay claims to Nuvoton as a result of customer's Insecure Usage, customer shall indemnify the damages and liabilities thus incurred by Nuvoton.

Please note that all data and specifications are subject to change without notice.
All the trademarks of products and companies mentioned in this datasheet belong to their respective owners.