控制SPI接口的LCD显示屏– ILI9341

NuMicro® 32 位系列微控制器范例代码介绍

文件信息

代码简述	本范例代码基于NUC126平台，透过SPI接口控制Ili9341的LCD屏幕
BSP 版本	NUC126_Series_BSP_CMSIS_v3.00.004
开发平台	NuTiny-NUC126

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 功能介绍

1.1 简介

本范例代码使用NUC126平台，透过SPI接口实现ILI9341 LCD Panel的控制。ILI9341是一颗LCD显示屏的控制IC，目前市面上多做成模块贩卖，用户需要了解如何控制ILI9341以驱动LCD显示屏。ILI9341的详细规格与指令参数请至其官方网站下载Datasheet，以了解详细操作内容。

2 代码介绍

2.1 初始化 PWM 模块

本函数初始化PWM模块以进行LCD屏幕亮度的调节。PWM的频率为1 kHz，占空比为50%。

```
static void _InitPWMModule(void)
{
    /* Using PWM1 channel 5 (PC14) for tunning back light brightness */
    SYS->GPC_MFPH &= ~(SYS_GPC_MFPH_PC14MFP_Msk);
    SYS->GPC_MFPH |= SYS_GPC_MFPH_PC14MFP_PWM1_CH5;

    /* Select and enable module clock */
    CLK_EnableModuleClock(PWM1_MODULE);
    CLK_SetModuleClock(PWM1_MODULE, CLK_CLKSEL1_PWM1SEL_PCLK1, NULL);

    /* Reset PWM1 module */
    SYS_ResetModule(PWM1_RST);

    /* PWM1 channel 5 frequency is 1000Hz, duty 50%, */
    PWM_ConfigOutputChannel(PWM1, 5, 1000, 50);

    /* Enable output of PWM1 channel 5 */
    PWM_EnableOutput(PWM1, PWM_CH_5_MASK);

    /* Start PWM counter */
    PWM_Start(PWM1, PWM_CH_5_MASK);
}
```

2.2 初始化 SPI 模块

初始化SPI模块以驱动LCD屏幕。SPI设定为Master模式、8 bit数据宽度，并运作在24 MHz的速度下。

```
static void _InitSPIModule(void)
{
    /* Using SPI1 for displaying the LCD */
    /* Switch the multi-function pin to SPI */
    SYS->GPD_MFPH &= ~(SYS_GPD_MFPH_PD13MFP_Msk | SYS_GPD_MFPH_PD14MFP_Msk |
SYS_GPD_MFPH_PD15MFP_Msk);
    SYS->GPD_MFPH |= (SYS_GPD_MFPH_PD13MFP_SPI1_MOSI | SYS_GPD_MFPH_PD14MFP_SPI1_MISO |
SYS_GPD_MFPH_PD15MFP_SPI1_CLK);

    /* Select and enable module clock */
    CLK_EnableModuleClock(SPI1_MODULE);
    CLK_SetModuleClock(SPI1_MODULE, CLK_CLKSEL2_SPI1SEL_PLL, 0);

    /* SPI open on master mode, mode 0, 8bit data width and operate on 24M Hz */
    SPI_Open(SPI_LCD_PORT, SPI_MASTER, SPI_MODE_0, 8, 24000000);

    /* Disable auto SS function */
    SPI_DisableAutoSS(SPI_LCD_PORT);

    /* Enable SPI */
    SPI_ENABLE(SPI_LCD_PORT);
}
```

2.3 初始化 LCD 屏幕所需的 MCU 硬件

此函数初始化了SPI与PWM模块，并设定PC14为GPIO的输出模式以作为屏幕背光的开关。

```
static void _InitMCUHWforLCD(void)
{
    /* Initial SPI Module for LCD display */
    _InitSPIModule();

    /* Initial PWM for backlight brightness control */
    _InitPWMModule();

    /* Set PC14 to output mode for LCD backlight on/off switch */
    GPIO_SetMode(PC, BIT14, GPIO_MODE_OUTPUT);
}
```

2.4 初始化 MuMaker 开发板的硬件

初始化MCU硬件以及驱动IC ILI9341。详细的ILI9341缓存器内容请参考ILI9341的Datasheet。

```
void Drv_NuMaker_HWInit(void)
{
    /* Initial NuMaker Hardware */
    /* Initial MCU Hardware */
    _InitMCUHWforLCD();

    /* Initial ILI9341 LCD Panel Hardware */
    Drv_ILI9341_LCD_Init();
}
```

2.5 Main 函数

Main函数中，将会做系统初始化、MCU硬件初始化以及ILI9341 (屏幕驱动IC) 的初始化。初始化后，while循环将会显示黄、绿、红三种颜色，并以每200 ms的速度进行切换。

```
int32_t main(void)
{
    uint32_t i = 0;
    /* Initial MCU System */
    SYS_Init();
    /* Initial NuMaker Hardware */
    Drv_NuMaker_HWInit();

    while (1)
    {
```

```
        /* Display color yellow */
        for (i = 0; i < (LCD_Resolution_X * LCD_Resolution_Y * 2); i++)
        {
            LCD_Set_Color(Yellow);
        }

        CLK_SysTickDelay(200000);

        /* Display color Green */
        for (i = 0; i < (LCD_Resolution_X * LCD_Resolution_Y * 2); i++)
        {
            LCD_Set_Color(Green);
        }

        CLK_SysTickDelay(200000);

        /* Display color Red */
        for (i = 0; i < (LCD_Resolution_X * LCD_Resolution_Y * 2); i++)
        {
            LCD_Set_Color(Red);
        }

        CLK_SysTickDelay(200000);
    }
}
```

3 软件与硬件环境

- 软件环境
  - BSP 版本
    - NUC126_Series_BSP_CMSIS_v3.00.004
  - IDE 版本
    - Keil uVersion 5.26
- 硬件环境
  - 电路组件
    - NuTiny-NUC126 * 1
    - 牛桥 Nu-Bridge * 1
    - Ili9341 LCD Panel

■ 接线图

1. 将NuTiny-NUC126的UART_RX0(PD.0)、UART_TX0(PD.1)连接至Nu-Bridge，打印讯息。设置终端机的COM Port与Baudrate，COM Port的编号可在设备管理器中找到「NuBridge Virtual Com Port (COMX)」，Baudrate设置为115200。

2. 将ILI9341依照以下连接方式，与NUC126连接。

UART RX	↔	UART_TX (PB.1)
UART TX	↔	UART_RX (PB.0)
GND		GND
Nu-Bridge		

LEDK1~K4	↔	PC.14
LEDA	↔	3VCC(3.3V)
3VCC	↔	3VCC(3.3V)
GND	↔	GND
LCM_SPI_MISO	↔	PD.14
LCM_SPI_MOSI	↔	PD.13
LCM_SPI_SS	↔	PD.12
LCM_DC	↔	PD.6
LCM_SPI_CLK	↔	PD.15
LCM_RESET	↔	RESET
ILI9341		NUC126

4 目录信息

- EC_NUC126_SPI_LCD_Ili9341_Readme_EN_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

5 如何执行范例程序

1. 根据目录信息章节进入 EC_NUC126_SPI_LCD_Ili9341_Readme_EN_V1.00 \SampleCode\ExampleCode\NUC126_SPI_LCD_ILI9341，双击路径中 SPI_LCD_Ili9341.uvproj 开启专案。
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
Nov. 20, 2019	1.00	1. 初版

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.