基于ML51实现电子纸模块控制

NuMicro® 8 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ML51的SPI及GPIO功能，实现控制微雪电子的电子纸模块 2.9inch e-Paper Module (B)
BSP 版本	ML51_BSP_Keil_C51_V1.0.0
开发平台	NT-ML51PC V1.1

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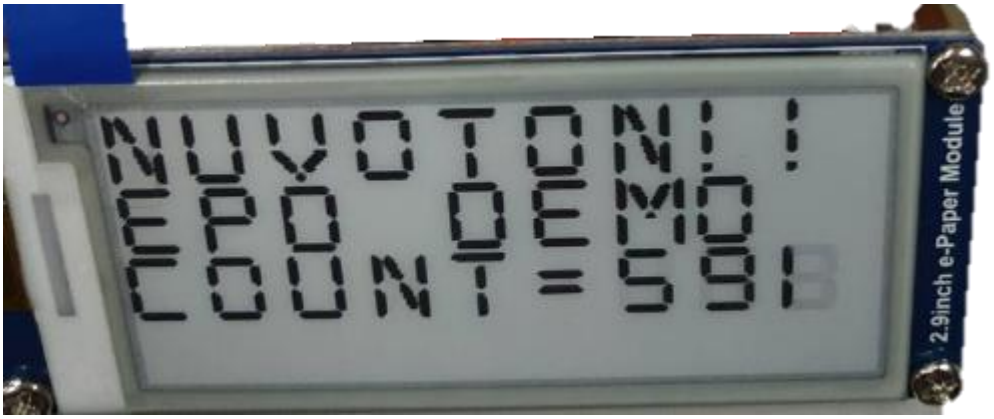
1 功能介绍

1.1 简介

电子纸是一种基于电泳显示技术(Electro-Phoretic Display，EPD)的反射式显示屏。显示的原理为带电离子在外加电场的透明或彩色液体中移动，经过翻转或流动来使像素变亮或变暗，并可以被制作在玻璃、金属或塑料基板上。
电泳技术优点包括耗能低、具有亮暗双稳态、反射型显示器具有良好的日光可读性、黑暗环境中具有高可读性、改变影像的瞬间才会耗电等。目前电泳式技术最大瓶颈在于彩色化困难，现今厂商多加装彩色滤光片处理，但会造成亮度、对比下降等问题。
模块相关信息请参考此网站：http://www.waveshare.net/wiki/2.9inch_e-Paper_Module_(B)

1.2 执行结果

本范例代码基于ML51的SPI及GPIO功能，实现控制微雪电子的电子纸模块 2.9inch e-Paper Module (B)。



2 代码介绍

(1) 先初始化与EPD模块相连接的GPIO，切换至PUSHPULL模式，再初始化SPI功能
(2) 透过SPI下指令给EPD模块进行初始化，然后传送显示内容

```
void main(void)
{
    //EPD GPIO INIT
    P25_INPUT_MODE;
    P24 = 1;
    P23 = 1;
    P22 = 1;
    P24_PUSHPULL_MODE;
    P23_PUSHPULL_MODE;
    P22_PUSHPULL_MODE;
    //SPI GPIO initial
    MFP_P00_SPI0_MOSI;
    P00_QUASI_MODE;
    MFP_P02_SPI0_CLK;
    P02_QUASI_MODE;
    //Initial SPI0 for EPD
    SPI_Open(SPI0, SPI_MASTER, 10, SPI_MODE_3, MSB_FIRST);
    EPD_Init(&epd, lut_full_update);

    EPD_SetFrameMemory(&epd, 0, 0); //clear ram
    EPD_DisplayFrame();

    EPD_SetFrameMemory(&epd, 0, 0); //clear ram
    EPD_DisplayFrame();

    //inital EPD function
    EPD_Init(&epd, lut_partial_update);

    while(1)
    {
        print_lcd(0, "Nuvoton!!!");
        print_lcd(32, " EPD Demo");
        sprintf(value, "count=%d", count_t);
        print_lcd(64, value);
        EPD_DisplayFrame();
        EPD_DelayMs(2000);
        count_t++;
    }
```

透过Send command来实现显示的子程序

```
/**
*  @brief: update the display
*          there are 2 memory areas embedded in the e-paper display
*          but once this function is called,
*          the the next action of SetFrameMemory or ClearFrame will
*          set the other memory area.
*/
void EPD_DisplayFrame(void)
{
    EPD_SendCommand(DISPLAY_UPDATE_CONTROL_2);
    EPD_SendData(0xC4);
    EPD_SendCommand(MASTER_ACTIVATION);
    EPD_SendCommand(TERMINATE_FRAME_READ_WRITE);
    EPD_WaitUntilIdle();
}
```

3 软件与硬件环境

- 软件环境
  - BSP 版本
    - ML51_BSP_Keil_C51_V1.0.0
  - 案例名称
    - WS_EPD_Module.uvproj
- 硬件环境
  - 硬件需求
    - NT-ML51PC V1.1 tiny board
    - 2.9inch e-Paper 模块(B)。
  - 接线图

将N76E003与2.9 inch e-Paper Module (B) 透过下列方式连接。

NT-ML51PC V1.1		2.9inch e-Paper Module (B)
VCC	↔	VCC
(GPIO INPUT)P25	↔	EPD_BUSY
(GPIO OUTPUT)P24	↔	EPD_RESET
(GPIO OUTPUT)P23	↔	EPD_DC
(GPIO OUTPUT)P22	↔	EPD_CS
(SPI CLK)P02	↔	EPD_CLK
(SPI MOSI)P00	↔	EPD_MOSI
GND	↔	GND

4 目录信息

- EC_ML51_WS_EPD_Module_V1.0
  - Library: Sample code header and source files.
    - Device: ML51 device header files.
    - Startup: Keil51 startup files
    - StdDriver: All peripheral driver header and source files.
  - Sample_Code
    - ExampleCode: Source file of example code.
      - WS_EPD_Module Source file of EPD display module.

5 如何执行范例程序

1. 本项目支持Keil uVersion 4.6及以上版本
2. 根据目录信息章节进入ExampleCode\WS_EPD_Module\KEIL文件夹，双击WS_EPD_Module.uvproj开启专案
3. 进入编译模式接口
   a. A. 编译
   b. B. 下载代码至内存
   c. C. 进入 / 离开除错模式
4. 进入除错模式接口
   a. 执行代码
5. 由EPD模块查看执行结果

6 修订纪录

日期	版本	描述
Sep. 24, 2019	1.00	1. 初始发布.

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