M4 DSP Linear Interpolation

NuMicro® 32 位系列微控制器範例代碼介紹

文件資訊

代碼簡述	本範例代碼使用M4內核DSP計算線性內插(Linear Interpolation)
BSP 版本	M480 Series BSP CMSIS V3.04.000
開發平台	NuMaker-PFM-M487 Ver 3.0

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1 功能介紹

1.1 簡介

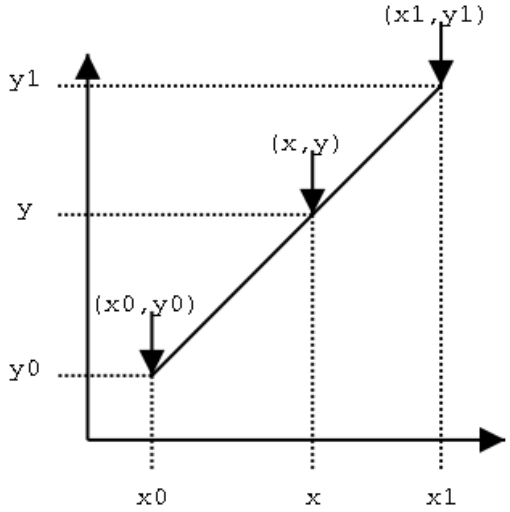
展示使用 CMSIS DSP 函式庫進行線性內插運算(Interpolation)，用戶可以直接使用這些函式，來實現自己的數學方程式運算。程式內比較了有無使用 DSP 計算時間的差異，並計算效率提升比率。

1.2 原理

假設目前已知座標*(x0,y0)*和*(x1,y1)*要得到線上區間內某一位置x在直線上的值。根據下圖所示，我們得到

$$\frac{y-y0}{x-x0}=\frac{y1-y0}{x1-x0}$$

由於x值已知，所以我們可以從公式得到y的值。



使用CMSIS DSP函式庫線性插值功能首先宣告x0的樣本數、起始值x0和x1值與值間隔，再來輸入y值數據，程式設定如下表，完成浮點數插值結構設定之後，再輸入x值執行程式，即可得到線性插值所得y值。

arm_linear_interp_instance_f32 S = {uint32_t nValues, float32_t x0, float32_t xSpacing, float32_t *pYData}		
參數：	nValues	x值的樣本數
	x0	x起始值
	xSpacing	x值與值之間隔
	*pYData	y值數據
回傳值：		無

arm_linear_interp_f32(arm_linear_interp_instance_f32 *S, float32_t x)		
參數：	*S	[in, out]浮點數插值結構
	x	[in] 輸入x值
回傳值：		線性插值y結果

1.3 執行結果

執行後會打印出以下資訊

```
+----------------------------------------+
|      DSP Interpolation Sample Code     |
+----------------------------------------+

Calculating time with DSP instruction is 0.004250 ms

Calculating time without DSP instruction is 0.004833 ms

Efficiency increase rate is 1.14
```

2 代碼介紹

使用CMSIS DSP函數庫進行線性內插運算(Linear Interpolation)運算：

```
    /* Calculate Liner interpolation with DSP, Calculation results will return to
testLinIntOutput */
    for(i=0; i<TEST_LENGTH_SAMPLES; i++) {
        testLinIntOutput[i] = arm_linear_interp_f32(&S, testInputSin_f32[i]);
    } ;
```

接著使用CPU進行相同的計算：

```
/* Calculate Interpolation */
float interp(int n,float x1,float xSpacing,float x)
{
    float y, y0, y1, x0;                    /* Nearest output values */
    int32_t i;                              /* Index variable */

    /* Calculation of index */
    i = (x - x1) / xSpacing;
    if(i < 0) {
      /* Iniatilize output for below specified range as least output value of table */
      y = arm_linear_interep_table[0];
    }
    else if(i >= n) {
      /* Iniatilize output for above specified range as last output value of table */
      y = arm_linear_interep_table[n - 1];
    }
    else {
      /* Calculation of nearest input values */
      x0 = x1 + i * xSpacing;
      x1 = x1 + (i + 1) * xSpacing;
      /* Read of nearest output values */
      y0 = arm_linear_interep_table[i];
      y1 = arm_linear_interep_table[i + 1];
      /* Calculation of output */
      y = y0 + (x - x0) * ((y1 - y0) / (x1 - x0));
    }
    /* returns output value */
    return (y);
}
```

把計數器換成時間，其中計數器時鐘源為HXT 12MHz：

```
    /* Calculate the time, timer clock source is 12M, unit is ms */
    DSPCalTime = (DSPCalTime/12000000) * 1000;
    CalTime = (CalTime/12000000)* 1000;
```

3 軟體與硬體環境

● 軟體環境

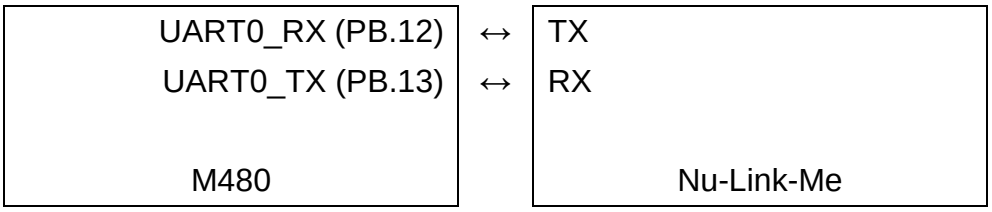
- ■ BSP 版本
  - ◆ M480 Series BSP CMSIS V3.04.000
- ■ IDE 版本
  - ◆ Keil uVersion 5.26

● 硬體環境

- ■ 電路元件
  - ◆ NuMaker-PFM-M487 or other M480 Development Board
- ■ 示意圖

M480 的 UART0_RX(PB.12)、UART0_TX(PB.13)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_M480_Interpolation_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 DSP_Interpolation.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
Jun. 25, 2019	1.00	1. 初始發布.

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