

M4 DSP Statistics Functions

NuMicro® 32 位系列微控制器范例代码介绍

文件信息

代码简述	本范例代码使用M4内核DSP计算均方根和标准差
BSP 版本	M480 Series BSP CMSIS V3.04.000
开发平台	NuMaker-PFM-M487 Ver 3.0

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1 功能介绍

1.1 简介

CMSIS DSP函数库有许多关于统计学的运算包含：

1. 取最大值
2. 取最小值
3. 取平均值
4. 平方平均数
5. 标准差
6. 变异数

在此范例程序使用CMSIS DSP函数库进行均方根和标准差运算，用户可以直接使用这些函数，来实现自己的数学方程式运算。程序内比较了有无使用DSP计算时间的差异，并计算效率提升比率。

1.2 原理

平方平均数运算(Quadratic mean)，又称均方根(RMS, Root Mean Square)在统计学中很常使用到，其数学表示式为下，程序设定如表1：

$$M = \sqrt{\frac{\sum_{i=1}^n x_i^2}{n}}$$

标准差(SD, Standard Deviation)，在机率统计中最常使用作为测量一组数值的离散程度之用。其数学表示式为下，其中u为x的平均值，程序设定如表2：

$$SD = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - u)^2}$$

arm_rms_f32 (float32_t *pSrc, uint32_t blockSize, float32_t *pResult)		
参数:	*pSrc	[in] 欲计算矩阵
	blockSize	[in] 矩阵样本数
	*pResult	[out] 计算结果
回传值:		无

表 1 方均根程序设定

arm_std_f32 (float32_t *pSrc, uint32_t blockSize, float32_t *pResult)		
参数:	*pSrc	[in] 欲计算数值
	blockSize	[in] 样本数
	*pResult	[out] 计算结果
回传值:		无

表 2 标准差程序设定

1.3 执行结果

执行后会打印出以下信息

```

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

Calculating time with DSP instruction is 0.005500 ms
Calculating time without DSP instruction is 0.390833 ms
Efficiency increase rate is 71.06

```

2 代码介绍

使用CMSIS DSP函数库进行均方根和标准差运算：

```
/* Calculate RMS (32 sample) with DSP */
arm_rms_f32(testInput_f32, blockSize, &DSP_RMSoutput);
/* Calculate standard deviation (32 sample) with DSP */
arm_std_f32(testMarks_f32, SDblockSize, &DSP_SDoutput);
```

接着使用CPU进行相同的计算：

```
/* RMS (number of samples, input data) */
float RMS(int size, float *input)
{
    uint32_t i;
    float32_t rms, sum;
    for(i=0; i<size; i++) {
        sum += pow(input[i], 2);
    }
    rms = sqrt(sum/size);
    return rms;}

/* Standard Deviation (number of samples, input data) */
float SD(int size, float *input)
{
    uint32_t i;
    float32_t tot, SDsum, average, SDvalue;
    for(i=0; i<size; i++) {
        tot = tot + input[i];
        average = tot/size;
    }
    for(i=0; i<size; i++) {
        SDsum = SDsum + pow(input[i] - average, 2);
    }
    SDvalue = sqrt(SDsum/(size-1));
    return SDvalue;
}
```

把计数器换成时间，其中计数器时钟源为HXT 12MHz：

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

3 软件与硬件环境

- 软件环境

- BSP 版本

- ◆ M480 Series BSP CMSIS V3.04.000

- IDE 版本

- ◆ Keil uVersion 5.26

- 硬件环境

- 电路组件

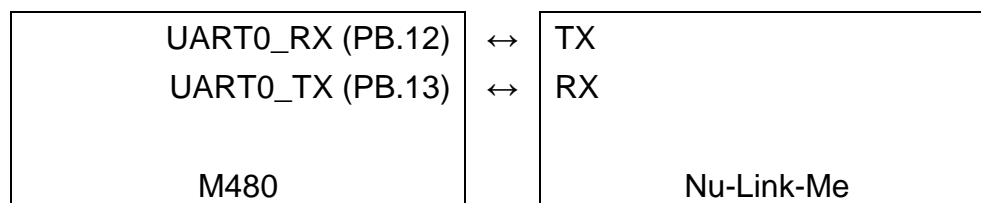
- ◆ NuMaker-PFM-M487 or other M480 Development Board

- 示意图

M480 的 UART0_RX(PB.12)、UART0_TX(PB.13)连接至 Nu-Link Me，打印讯息。







设置终端机的 COM Port 与 Baud，COM Port 的编号可在设备管理器中找到「NuBridge

Virtual Com Port (COMX)」，Baud 设置为 115200。



4 目录信息

 EC_M480_DSP_Statistics_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 ExampleCode 路径中的 KEIL 文件夹，双击 DSP_Statistics.uvproj
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
Jun. 25, 2019	1.00	1. 初始发布.

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