

M4 DSP Statistics Functions

Example Code Introduction for 32-bit NuMicro[®] Family

Information

Application	This sample code uses the M4 DSP to calculate RMS and Standard Deviation
BSP Version	M480 Series BSP CMSIS V3.04.000
Hardware	NuMaker-PFM-M487 Ver 3.0

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1 Function Description

1.1 Introduction

This sample code uses the CMSIS DSP library to calculate statistics functions, including

1. Maximum
2. Minimum
3. Mean
4. Root mean square (RMS)
5. Standard deviation
6. Variance

User can use these functions to implement mathematical equations. The sample code compares the difference between using the DSP calculation time and calculates the efficiency improvement ratio.

1.2 Principle

Calculates the Root Mean Square (RMS) of the elements in the input vector. The underlying algorithm is used: :

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

Calculates the standard deviation (SD) of the elements in the input vector. The underlying algorithm is used:

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

arm_rms_f32 (float32_t *pSrc, uint32_t blockSize, float32_t *pResult)		
Parameters :	*pSrc	[in] points to the input vector
	blockSize	[in] number of samples in input vector
	*pResult	[out] root mean square value returned here
Returns :		none

arm_std_f32 (float32_t *pSrc, uint32_t blockSize, float32_t *pResult)		
Parameters :	*pSrc	[in] points to the input vector
	blockSize	[in] number of samples in input vector
	*pResult	[out] standard deviation value returned here
Returns :		none

1.3 Demo Result

```

+-----+
| 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 Code Description

Use CMSIS DSP library to calculate RMS and SD :

```
/* 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);
```

And calculation RMS and SD without DSP :

```
/* 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;
}
```

Change the counter to time, where the timer clock source is HXT 12MHz :

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

3 Software and Hardware Environment

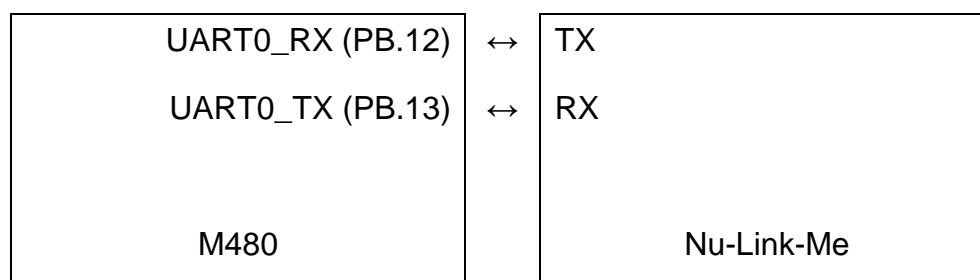
- **Software environment**

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

- **Hardware environment**







- Circuit components
 - ◆ NuMaker-PFM-M487 or other M480 Development Board
- Diagram

M480's UART0_RX (PB.12) and UART0_TX (PB.13) are connected to Nu-Link Me to print the message. Set COM port and Baud. The number of the COM Port can be found in the device manager "NuBridge Virtual Com Port (COMX)" and Baud is set to 115200.



4 Directory Information

 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 How to Execute Example Code

1. Browsing into sample code folder by Directory Information (section 4) and double click DSP_Statistics.uvproj
2. Enter Keil compile mode
 - a. Build
 - b. Download
 - c. Start/Stop debug session
3. Enter debug mode
 - a. Run

6 Revision History

Date	Revision	Description
Jun. 25, 2019	1.00	1. Initially issued.

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