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NatureDSP Math

Overview

NatureDSP Math library is a fixed point digital signal processing library. NatureDSP Math efficiently implements accurate fixed point representation of commonly used mathematic routines. NatureDSP Math saves product development time. It utilizes 100% of fixed point DSPs capabilities requiring minimum CPU cycles. The NatureDSP Math library is useful for signal processing algorithms developers and digital communication system designers.

Features

- supports ETSI inline functions and macros for ***compatibility*** with G.7xx and GSM codecs
- ***accurate*** approximation of ANSI C mathematical functions
- ***true*** fixed point implementation with saturation, no floating point
- the ***best real-time performance***
- fully ***portable ANSI C code***
- library for MS Visual Studio ***for free*** – enables development under PC environment

Applications

The NatureDSP Math library is used in mathematically extensive software running on DSP/RISC processors in the hard real time:

- software defined radio
- telephony
- audio/voice
- codecs
- digital modems

Specifications

Function	Input precision		Output precision		saturation
	16-bit	32-bit	16-bit	32-bit	
Basic operations – inline functions or macros:					
Add, subtract	x	x	x	x	x
Integer/fractional multiply/MAC	x	x	x	x	x
Integer/fractional division	x	x	x	x	x
Exponent	x	x	x		
Arithmetic shift	x	x	x	x	x
Rounding	x	x	x	x	x
Absolute value	x	x	x	x	x
Negation	x	x	x	x	x
Mathematics:					
square root	x	x	x	x	x
logarithms (natural, base 10. base 2)	x	x	x		x
sine/cosine	x	x	x		x
tangent	x	x	x		x
ceil/floor	x	x	x	x	x
exponential function, raising to a power	x			x	x
full arctangent	x	x	x		x
sinc		x	x		x
conversion to decibels	x	x	x		x

Availability

This library is available in binaries and in source code written on fully portable C-language for:

- Texas Instruments TMS320C54xx, TMS320C55xx, TMS320C64xx, OMAP, DaVinci
- ARM7, ARM9, ARM9E
- MS Windows (Object library)

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Performance

MIPS performance depends on multiple factors, i.e. DSP family, memory layout, and so on. Here is the performance comparison table for typical cases for C55 DSP. For reference, Texas Instruments DSPLIB metrics are given.

	NatureDSP Math			TI's DSPLIB		
Function	Name	Cycles	Accuracy	Name	Cycles	Accuracy
sine	S_sin_l	38	max.error $6.2*10^{-5}$			
cosine	S_cos_l	39	max.error $6.2*10^{-5}$			
tangent	L_tan_s	65	max.error $9.2*10^{-5}$ @|x|<=π/4, max.relative error <$1.4*10^{-4}$			
full arctangent	S_atan2_ss	130	max.error $3.1*10^{-5}$	atan2_16	104	max.error $1.2*10^{-4}$
square root	S_sqrt_s	69	max.error $3.1*10^{-5}$	sqrt_16	74	max.error $1.3*10^{-3}$
Base 2 logarithm	S_log2_l	87	max.error $2.*10^{-3}$	log_2	89	max.error $2.1*10^{-2}$ for x>0.001, lesser arguments cause error up to 1
Natural logarithm	S_ln_l	97	max.error $2.*10^{-3}$	logn	96	max.error $7.8*10^{-3}$ for x>0.001, lesser arguments cause error up to 1
Base 10 logarithm	S_log10_l	97	max.error $2.*10^{-3}$	log_10	104	max.error $1.6*10^{-2}$ for x>0.001, lesser arguments cause error up to 1
sinc	S_sinc_l	170	average error $1.5*10^{-5}$, maximum error $5.3*10^{-5}$			
2 raised to a power	L_pow2_s	107	max.error <1 LSB @x<1, max. relative accuracy $3*10^{-5}$			
exponential function	L_pow_s	142	max.error <1 LSB @x<0, max. relative accuracy $4.6*10^{-5}$	expn	42	max.error $1.9*10^{-2}$. Works in range [-1,1} only
10 raised to a power	L_pow10_s	142	max.error <1 LSB @x<0, max. relative accuracy $3.9*10^{-5}$			
x raised to a power	L_pow_ss	238	max.error <2 LSB @x<0, max. relative accuracy $1.2*10^{-3}$, see NOTE			

NOTE: depends on x, numbers are given for x=10

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