IDP

Fixed-Point Matrix Multiplication

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Problem statement and Implementation Strategy

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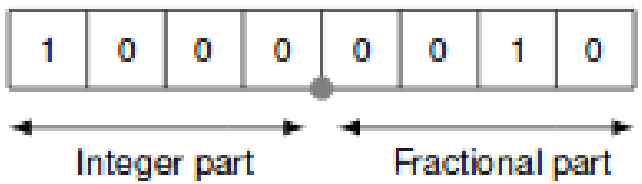
Introduction

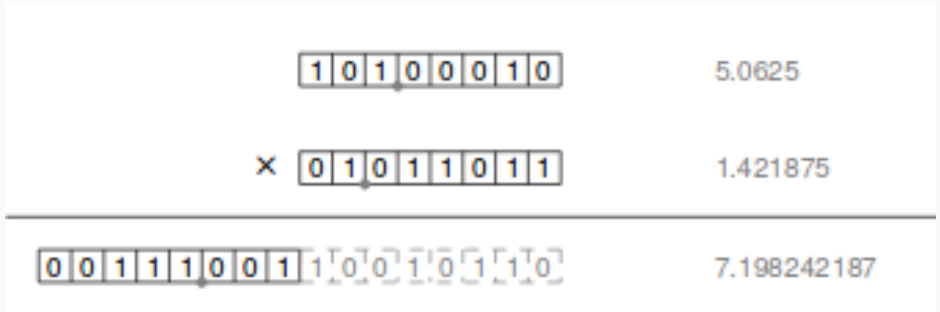
Fixed Point Matrix Multiplication

The main idea of fixed point arithematic is to interpret bit words as integers coupled with a scale factor: $\frac{z}{2^n}$



z	$2^7 + 2^1 = 130$
Value in fixed-point	$\frac{130}{2^4} = \frac{2^7+2^1}{2^4} = 2^3 + 2^{-3} = 8.125$

Multiplication: The product of a $Q_{a,b}$ variable by a $Q_{c,d}$ yields a $Q_{a+b,c+d}$ variable.



Fixed Point Matrix Multiplication

Table 1: Fixed-Point Examples

Binary	Hex	Integer	Floating Point Fraction	Fixed-Point Fraction	Actual
0100000000000000	4000	16384	0.50000000	0.50000000	1/2
0010000000000000	2000	8192	0.25000000	0.25000000	1/4
0001000000000000	1000	4096	0.12500000	0.12500000	1/8
0000100000000000	0800	2048	0.06250000	0.06250000	1/16
0000010000000000	0400	1024	0.03125000	0.03125000	1/32
0000001000000000	0200	512	0.01562500	0.01562500	1/64
0000000100000000	0100	256	0.00781250	0.00781250	1/128
0000000010000000	0080	128	0.00390625	0.00390625	1/256
0000000001000000	0040	64	0.00195312	0.00195312	1/512
0000000000100000	0020	32	0.00097656	0.00097656	1/1024
0000000000010000	0010	16	0.00048828	0.00048828	1/2048
0000000000001000	0008	8	0.00024414	0.00024414	1/4096
0000000000000100	0004	4	0.00012207	0.00012207	1/8192
0000000000000010	0002	2	0.00006104	0.00006104	1/16384
0000000000000001	0001	1	0.00003052	0.00003052	1/32768
0010101010101011	2AAB	10923	0.33333000	0.33334351	0.33333
0101101001111111	5A7F	23167	0.70700000	0.70700073	0.707
0000000000001010	000A	10	0.0003141592	0.00030518	0.0003141592
0000000000000011	0003	3	0.000086476908	0.00009155	0.000086476908

Fixed Point Matrix Multiplication

- It is similar to a normal matrix multiplication, whereas here we use fixed point multiplication between the numbers.
- The input is stored in the BRAM memory block and after the computation output is also stored in BRAM memory block

Problem Statement

Problem Statement

- input matrices will be taken from keypad.
- fixed point numbers must be used to multiply and generate a matrix in Ico board (result of multiplication of two matrices).
- the output will be displayed via Arduino.

Implementation Strategy

Implementation Strategy

- mode of input is keypad which is connected to Arduino.
- Arduino converts floating point input to fixed point output.
- Ico board receives input from Arduino where matrix multiplication is programmed.
- Ico board sends the output after the multiplication process to Arduino.
- The output matrix can be displayed in Arduino-python interface after floating point conversion.

The Project will be implemented for (3×3) matrix. And 8-bit fixed-point numbers will be used.

Updates till now

Updates

- implemented multipliction of two (4×4) matrices in verilog.
- The input for the matrices are signed 8-bit each and output is signed 11-bit.
- The algorithm for Arduino to convert decimal inputs to binary output is completed. Inputs are taken from Serial monitor using Serial.read and then converted to binary and fractional binary.

THANK YOU