

Fixed Point Vs Floating Point

Tasked performed

- In Makefile folder directories with name as given below has been created.
 - include
 - lib
 - src
 - obj
 - bin
- Makefile created
- Lib directory contains fixedptc.h file
- src directory contains fixedpt_print, matrix.c and print_matrix.c
- obj directory contains all the object files created when .c files are executed
- bin directory contain the executable file
- Implemented fixed point multiplication and floating point multiplication in c & matlab
- Dimension of every matrix is changing by 5
- Every time a random matrix is generated
- Random matrix is multiplied with itself and the time it takes to calculate is noted down to file
- Time is calculated for both floating point and fixed-point matrix multiplication
- Graph plotted using gnu plot in which time is y axis and log of dimension is x axis
- In terminal window we only have type make INT="Value Of Maximum Dimension" and graph will be generated and will also get saved in Makefile directory
- Graph has been plotted in matlab to compare performance of C and Matlab

Why to convert floating point to fixed point?

In the world of computers and system data is stored in form of binary. Binary is fixed length sequence of bits 0's and 1's. How it is interpreted depends mainly on data types. Algorithms in HDL used are generally fixed point as registers should be large enough to have value of parameter with desired precision. As it is important to know the size of variables and registers. As we know that it is not possible to implement large number of flip-flops in hardware as it will increase size and cost and power.

Fixed point and Floating-Point Matrix Multiplication Performance analysis using C

Dimension	log of dimension	Time of Floating-point	Time of Fixed point
1	0.000000	0.000007	0.000004
6	1.791759	0.000004	0.000020
11	2.397895	0.000013	0.000035
16	2.772589	0.000020	0.000066
21	3.044523	0.000038	0.000140
26	3.258096	0.000075	0.000233
31	3.433987	0.000134	0.000368
36	3.583519	0.000215	0.000552
41	3.713572	0.000278	0.000777
46	3.828641	0.000400	0.001067
51	3.931826	0.000523	0.001458
56	4.025352	0.001487	0.004136
61	4.110874	0.000905	0.002420
66	4.189655	0.001139	0.003045
71	4.262680	0.001407	0.003728
76	4.330733	0.001663	0.004524
81	4.394449	0.001984	0.005334
86	4.454347	0.002506	0.006724
91	4.510859	0.002815	0.007575
96	4.564348	0.003322	0.009065
101	4.615120	0.004015	0.010410
106	4.663439	0.004415	0.011976
111	4.709530	0.005159	0.013856
116	4.753590	0.005844	0.015659
121	4.795791	0.006654	0.017737
126	4.836282	0.008334	0.020230
131	4.875197	0.008487	0.022270
136	4.912655	0.009408	0.025025
141	4.948760	0.010417	0.028055
146	4.983607	0.011618	0.031747
151	5.017280	0.012855	0.034473
156	5.049856	0.014231	0.037770
161	5.081404	0.015893	0.041798
166	5.111988	0.017056	0.045324
171	5.141664	0.019242	0.050569
176	5.170484	0.021171	0.054650
181	5.198497	0.024294	0.060077
186	5.225747	0.025617	0.066151
191	5.252274	0.030064	0.072685
196	5.278115	0.031861	0.078589
201	5.303305	0.035650	0.085704
206	5.327876	0.037829	0.091277
211	5.351858	0.039715	0.099105
216	5.375278	0.045009	0.105656
221	5.398163	0.049058	0.114213
226	5.420535	0.049214	0.121605

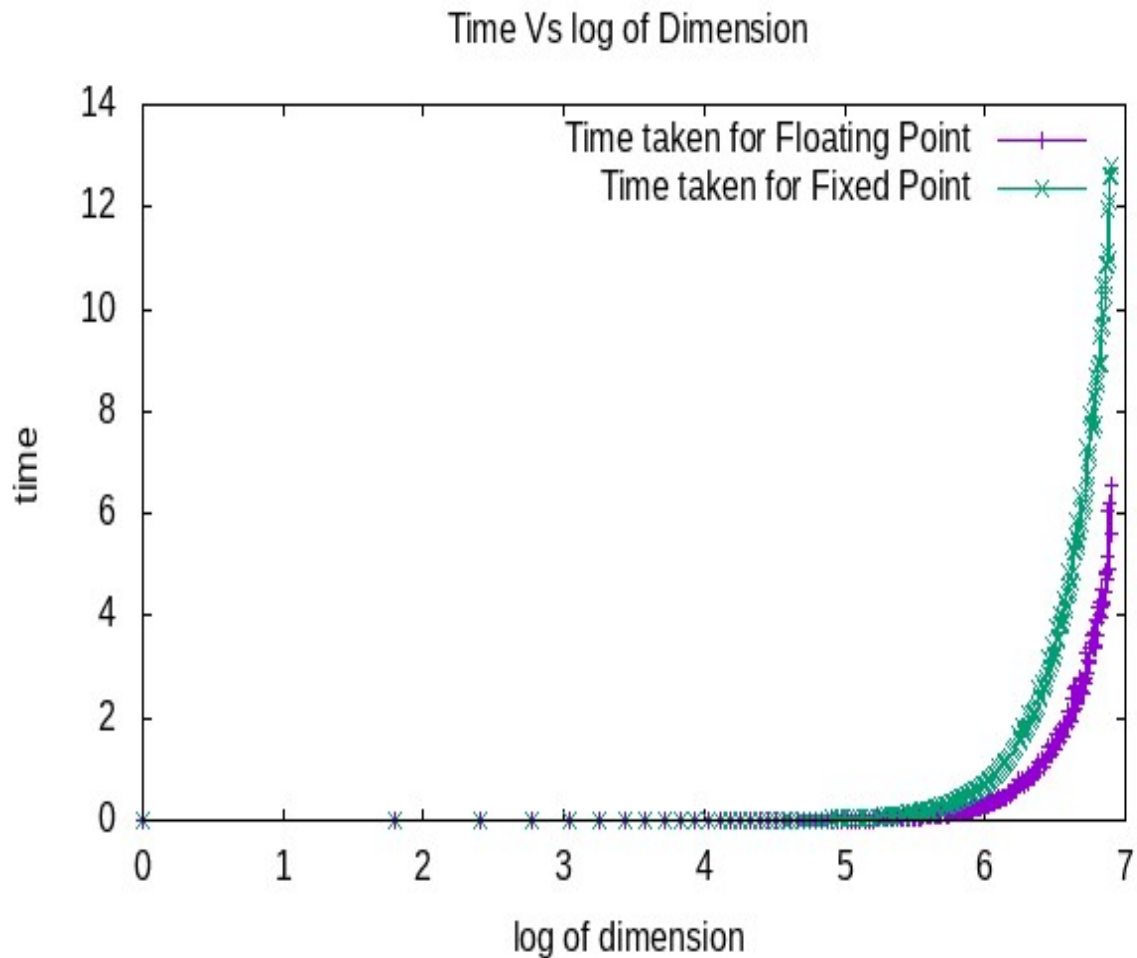
Dimension	log of dimension	Time of Floating-point	Time of Fixed point
231	5.442418	0.051099	0.131811
236	5.463832	0.060452	0.140118
241	5.484797	0.063955	0.149586
246	5.505332	0.062001	0.156028
251	5.525453	0.067426	0.169440
256	5.545177	0.072898	0.175837
261	5.564520	0.077968	0.187603
266	5.583496	0.079285	0.198385
271	5.602119	0.087855	0.213163
276	5.620401	0.094275	0.223128
281	5.638355	0.100705	0.236684
286	5.655992	0.103870	0.251981
291	5.673323	0.104876	0.262195
296	5.690360	0.118230	0.275621
301	5.707110	0.124738	0.289746
306	5.723585	0.121499	0.306271
311	5.739793	0.123220	0.314001
316	5.755742	0.144537	0.336535
321	5.771441	0.151405	0.352825
326	5.786897	0.142090	0.359884
331	5.802118	0.153978	0.385983
336	5.817111	0.173967	0.407114
341	5.831882	0.185291	0.429102
346	5.846439	0.177364	0.441347
351	5.860786	0.192747	0.465915
356	5.874931	0.207678	0.482239
361	5.888878	0.218396	0.504093
366	5.902633	0.218355	0.530883
371	5.916202	0.219189	0.546509
376	5.929589	0.246629	0.572035
381	5.942800	0.255368	0.592326
386	5.955837	0.248559	0.615906
391	5.968708	0.248942	0.628042
396	5.981414	0.294992	0.677592
401	5.993961	0.301703	0.693895
406	6.006353	0.281558	0.705950
411	6.018593	0.305886	0.751271
416	6.030685	0.340428	0.782076
421	6.042633	0.354084	0.811000
426	6.054440	0.355726	0.846363
431	6.066108	0.357775	0.869809
436	6.077642	0.394976	0.903958
441	6.089045	0.409512	0.939075
446	6.100319	0.448446	1.033793
451	6.111467	0.414890	1.011976
456	6.122493	0.456056	1.043824
461	6.133398	0.470798	1.078989
466	6.144186	0.462561	1.130915
471	6.154858	0.464716	1.137253
476	6.165418	0.525101	1.195818

Dimension	log of dimension	Time of Floating-point	Time of Fixed point
481	6.175867	0.542353	1.239444
486	6.186209	0.514679	1.251624
491	6.196444	0.544587	1.321221
496	6.206576	0.597209	1.366265
501	6.216606	0.615942	1.441964
506	6.226537	0.599525	1.450452
511	6.236370	0.788244	1.706190
516	6.246107	0.674077	1.536250
521	6.255750	0.696961	1.584084
526	6.265301	0.808857	1.831044
531	6.274762	0.694670	1.693077
536	6.284134	0.756161	1.724625
541	6.293419	0.777032	1.770635
546	6.302619	0.755801	1.826485
551	6.311735	0.908478	2.062113
556	6.320768	0.843660	1.922437
561	6.329721	0.867200	1.981339
566	6.338594	0.906151	2.098066
571	6.347389	0.861521	2.087550
576	6.356108	0.938499	2.139066
581	6.364751	0.963086	2.194111
586	6.373320	0.932726	2.256533
591	6.381816	1.141087	2.593878
596	6.390241	1.040098	2.371703
601	6.398595	1.066666	2.429967
606	6.406880	1.169053	2.671944
611	6.415097	1.056212	2.559609
616	6.423247	1.149178	2.626065
621	6.431331	1.180642	2.689011
626	6.439351	1.139102	2.767711
631	6.447306	1.416199	3.198709
636	6.455199	1.267754	2.896553
641	6.463029	1.294411	2.958592
646	6.470799	1.513809	3.412689
651	6.478509	1.281186	3.096482
656	6.486161	1.387092	3.158131
661	6.493754	1.421769	3.239942
666	6.501290	1.372029	3.319140
671	6.508769	1.676769	3.750703
676	6.516193	1.517022	3.549661
681	6.523562	1.565361	3.542797
686	6.530878	1.771122	4.042551
691	6.538140	1.556902	3.800209
696	6.545350	1.691409	3.803025
701	6.552508	1.702539	3.866481
706	6.559615	1.638354	3.963026
711	6.566672	1.904523	4.337001
716	6.573680	1.819191	4.129399
721	6.580639	1.857685	4.215685
726	6.587550	2.152617	4.880099

Dimension	log of dimension	Time of Floating-point	Time of Fixed point
731	6.594413	1.820488	4.400470
736	6.601230	1.982365	4.489101
741	6.608001	2.016249	4.573317
746	6.614726	1.935006	4.684683
751	6.621406	2.358343	5.380926
756	6.628041	2.147585	4.856685
761	6.634634	2.583930	5.283759
766	6.641182	2.639146	5.835713
771	6.647688	2.178046	5.243515
776	6.654152	2.323663	5.373156
781	6.660575	2.421542	5.482156
786	6.666957	2.262985	5.486818
791	6.673298	2.763810	6.335991
796	6.679599	2.515786	5.680555
801	6.685861	2.552356	5.828641
806	6.692084	2.722567	6.320621
811	6.698268	2.502714	6.047339
816	6.704414	2.718168	6.159321
821	6.710523	2.764876	6.227602
826	6.716595	2.688018	6.410635
831	6.722630	3.266944	7.321617
836	6.728629	2.900014	6.566215
841	6.734591	3.114255	6.736282
846	6.740520	3.355369	7.946181
851	6.746412	3.073856	7.112509
856	6.752270	3.150484	7.181825
861	6.758094	3.628464	7.747262
866	6.763885	3.471644	7.893506
871	6.769642	3.658188	8.309724
876	6.775366	3.375635	7.666376
881	6.781058	3.419398	7.746091
886	6.786717	3.939540	8.681031
891	6.792345	3.384014	8.388717
896	6.797940	4.171485	8.836790
901	6.803505	3.859208	8.527279
906	6.809039	3.625326	8.617125
911	6.814543	4.253015	9.496972
916	6.820016	4.031468	8.948589
921	6.825460	3.959661	8.946922
926	6.830874	4.493249	10.456968
931	6.836259	4.148222	9.632303
936	6.841616	4.272865	9.934695
941	6.846943	4.211758	9.663410
946	6.852242	4.447521	10.270590
951	6.857514	4.888705	10.891078
956	6.862758	4.833952	10.456809
961	6.867974	5.142945	11.143589
966	6.873164	6.068195	11.979919
971	6.878326	4.731937	10.892214
976	6.883462	6.202934	12.110210

Dimension	log of dimension	Time of Floating-point	Time of Fixed point
981	6.888573	4.937825	10.953271
986	6.893656	6.218135	12.604069
991	6.898715	5.634067	12.795351
996	6.903747	6.535902	12.592686

GNU PLOT



Time taken by floating point matrix multiplication is less than as compared to fixed point matrix multiplication. Fixed Point time graph is highly exponential increasing rapidly as compared to floating point as the time required to calculate fixed point matrix is more than that of floating-point matrix.

Matlab Analysis

Matlab code for fixed point and floating point

```
function mat_mul()
prompt="enter value of n ";%enter the dimension of matrix
n=input(prompt);
p=50;
% upto which the for loop will run at an advancement of 50
for k=1:p:n
x1=fi(randi([1 10],k,k)); %random fixed point matrix is created
tic; %stopwatch initialisation
y=x1*x1;%multiplication of fixed point matrix
r(k)=toc;%stopwatch closed
end
for i=1:p:n
x=(randi([1 100],i,i));%random floating point matrix is created
tic;%stopwatch initialisation
y=x*x;%multiplication of floating point matrix
t(i)=toc;
end
l=t(1:p:end);
z=r(1:p:end);
s=1:p:n;
j=log10(s);
    figure
    plot(j,l,j,z)
    title("Fixed Point Vs Floating Point")
    xlabel("Dimension(in log scale)")
    ylabel("Time for product matrix(in sec)")
    figure
    plot(j,l)
    title("Dimension vs Time for Floating Point")
    xlabel("Dimension(on log scale)")
    ylabel("Time taken for matrix multiplication(in sec)")
    figure
    plot(j,z)
    title("Dimension of matrix vs Time taken for fixed point")
    xlabel("Dimension of matrix (on log scale)")
    ylabel("Time for matrix multiplication(in sec)")
```

FIGURE-1

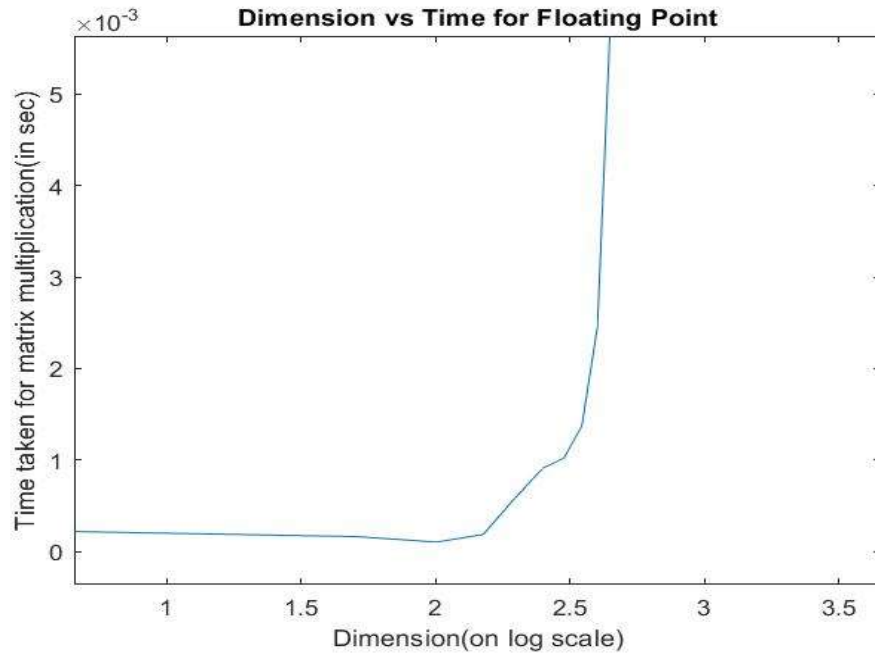


FIGURE -2

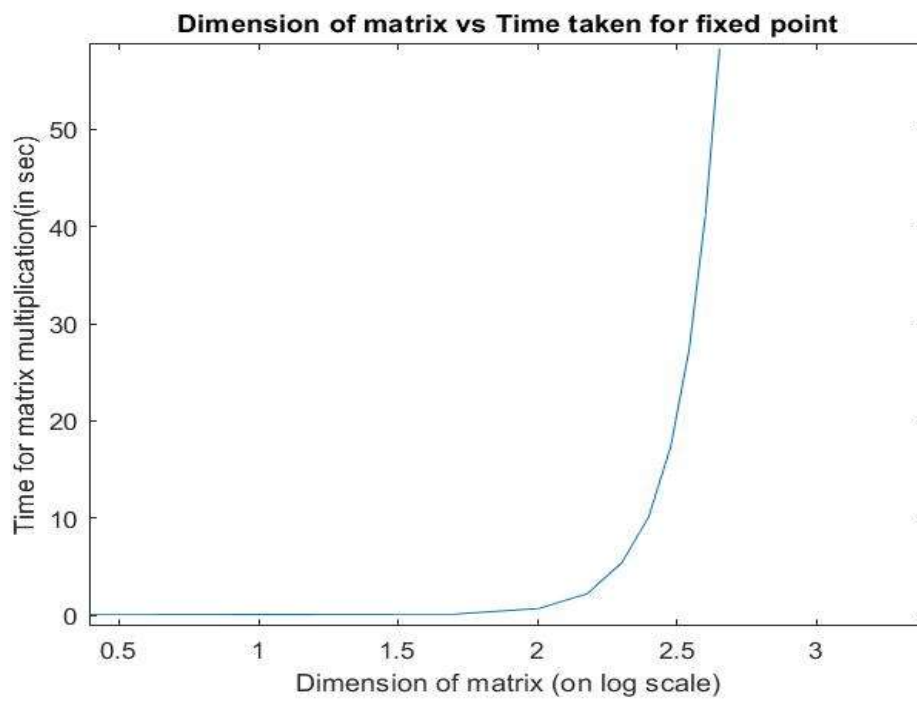
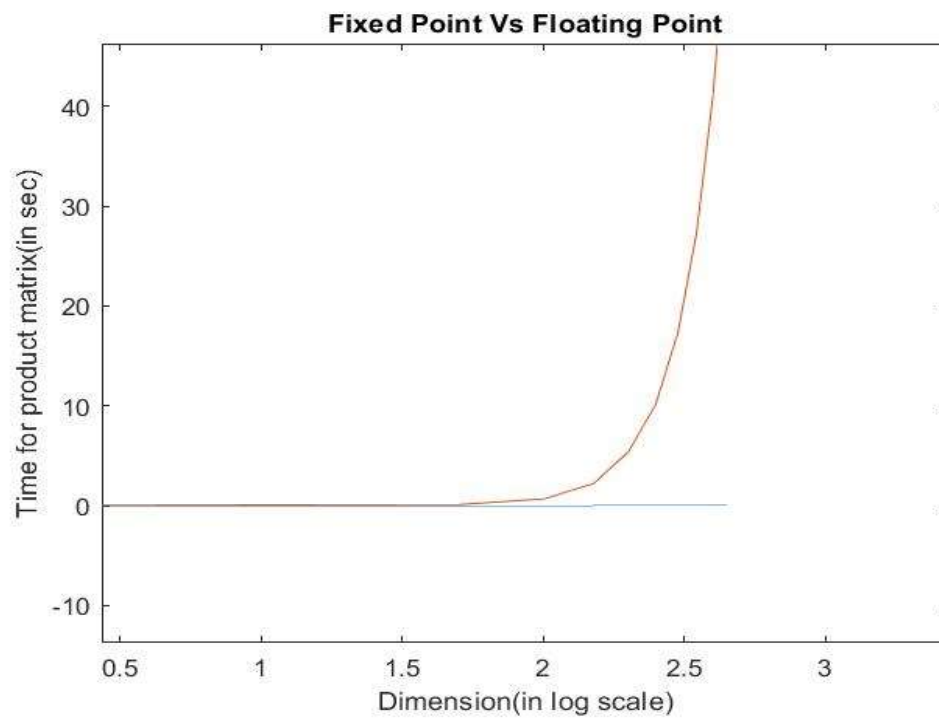


FIGURE-3



Time taken to compute floating point matrix multiplication is infinitesimally small as compared to time taken to compute the matrix multiplication of fixed-point matrix. As shown in the above figure 3 the graph of floating-point matrix multiplication time is equal to zero. Also, time taken for higher dimension in floating point matrix multiplication is also growing exponentially. Figure1 is only showing floating point matrix multiplication and how it is growing according to dimension and Figure 2 is showing fixed point matrix multiplication and how it is growing according to dimension.

Conclusion

- Time taken in MATLAB for Floating point matrix multiplication is less compared to time taken in C, Performance of MATLAB here is more.
- Time taken in MATLAB is more for Fixed point matrix multiplication when compared to C, Performance of MATLAB is less
- Time taken for execution of Fixed-point multiplication is more than floating matrix multiplication in both C and MATLAB.
- The difference in time of execution for MATLAB and in C is because of the algorithm written in MATLAB may have more time complexities and space complexities as compared to the one in C.