Homework 2 Write-Up, CS 5220, 2014 Fall

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We tested the simulation procedure using the parameter specification in *params_time.lua*, with the serial code and the parallel code using 2-8 processors. Table 1 shows the actual timing results.

Table 1: Timing results (4000 time steps) with different mesh sizes and different processor numbers.

# of proc n	1	2	3	4	5	6	7	8
10000	**0.0923**	0.1002	0.1069	0.1032	0.1163	0.1215	0.1263	0.1174
20000	0.1924	0.1615	0.1504	0.1342	0.1430	0.1456	0.1389	**0.1319**
30000	0.2850	0.2139	0.1946	0.1669	0.1691	0.1660	0.1569	**0.1488**
40000	0.3816	0.2679	0.2400	0.2037	0.1979	0.1826	0.1758	**0.1634**
50000	0.4739	0.3152	0.2702	0.2422	0.2252	0.2051	0.1961	**0.1798**
60000	0.5701	0.3665	0.3106	0.2750	0.2505	0.2271	0.2159	**0.1964**
70000	0.6638	0.4132	0.3402	0.3111	0.2745	0.2481	0.2374	**0.2157**
80000	0.7597	0.4679	0.3817	0.3510	0.2969	0.2694	0.2552	**0.2326**
90000	0.8601	0.5295	0.4092	0.3862	0.3334	0.2873	0.2762	**0.2530**
100000	0.9587	0.5781	0.4645	0.4565	0.3589	0.3115	0.2966	**0.2654**

Figure 1 shows a visual comparison in a plot.

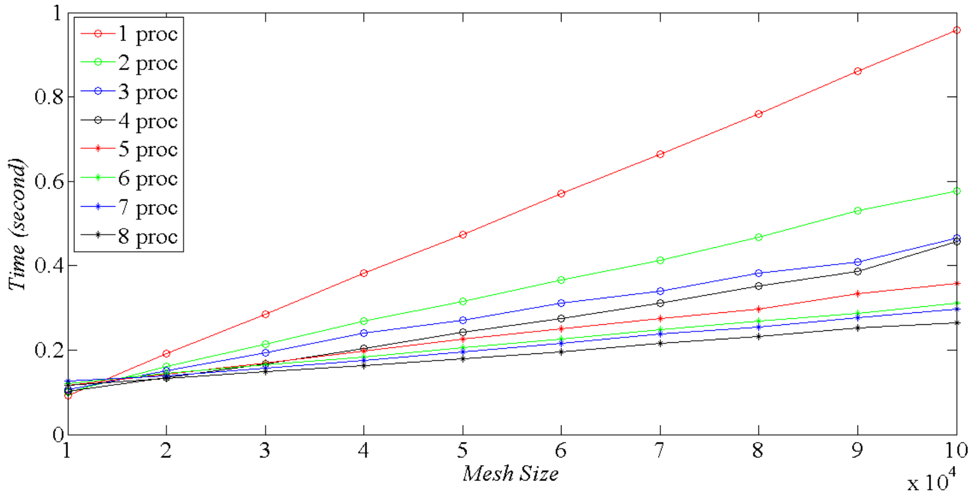

Figure 1: Comparison of time using different numbers of processors (4000 time steps).

It can be seen that when the mesh size is small, the serial version runs fastest. As the mesh size increases, parallel versions gradually outperform the serial version, and with more processors the increasing becomes more significant.

The expression of the time it takes to complete one time step:

$$t = \gamma \cdot \frac{n_{mesh}}{n_{proc}} + t_{comm}$$

The speedup:

$$speedup = \frac{\gamma \cdot n_{mesh}}{t} = \frac{\gamma \cdot n_{mesh}}{t_{comm} + \frac{\gamma \cdot n_{mesh}}{n_{proc}}}$$

According to the model we have:

$$t_{comm} = \alpha + \beta \cdot M$$

With as many processors as we want, the maximum speedup is

$$speedup_{max} = \frac{\gamma \cdot n_{mesh}}{t_{comm}}$$

Using the data of computing 100000 mesh points with 1-8 processors, we can estimate that $\gamma = 0.24 \cdot 10^{-8} second$.

Using the *ping-pong* program, we got the plot shown in Figure 2. After regression we have $\alpha = 8.12 \cdot 10^{-6}$ and $\beta = 4.87 \cdot 10^{-10}$.

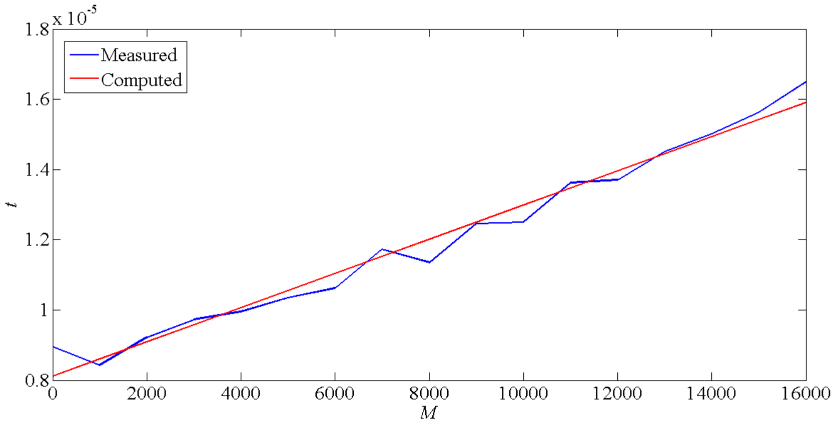

Figure 2: Measured time and computed time of the ping-pong program.

Using $t_{comm} = 3.64 \cdot 10^{-5} second$, we have the plot showing in Figure 3. It can be seen that the model fits the measured values quite well. However, the t_{comm} we used in Figure 3 does not agrees perfectly with the t_{comm} computed from α and β. This indicates our model for computing the speedup is correct but the model for computing the communication time still needs improvement.

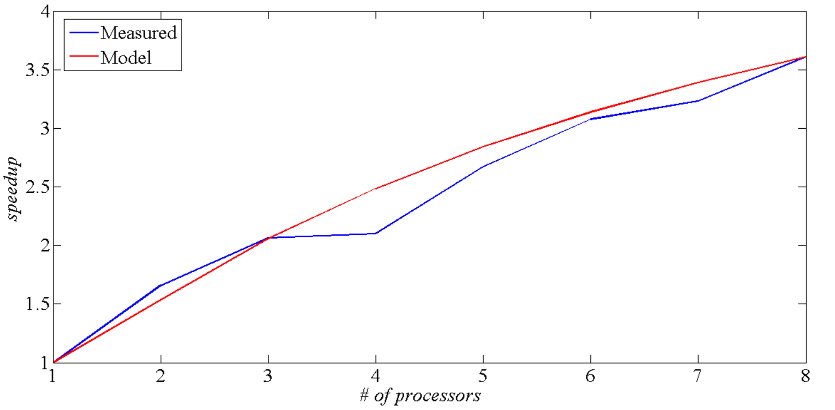

Figure 3: Measured speedup and computed speedup using the derived model.