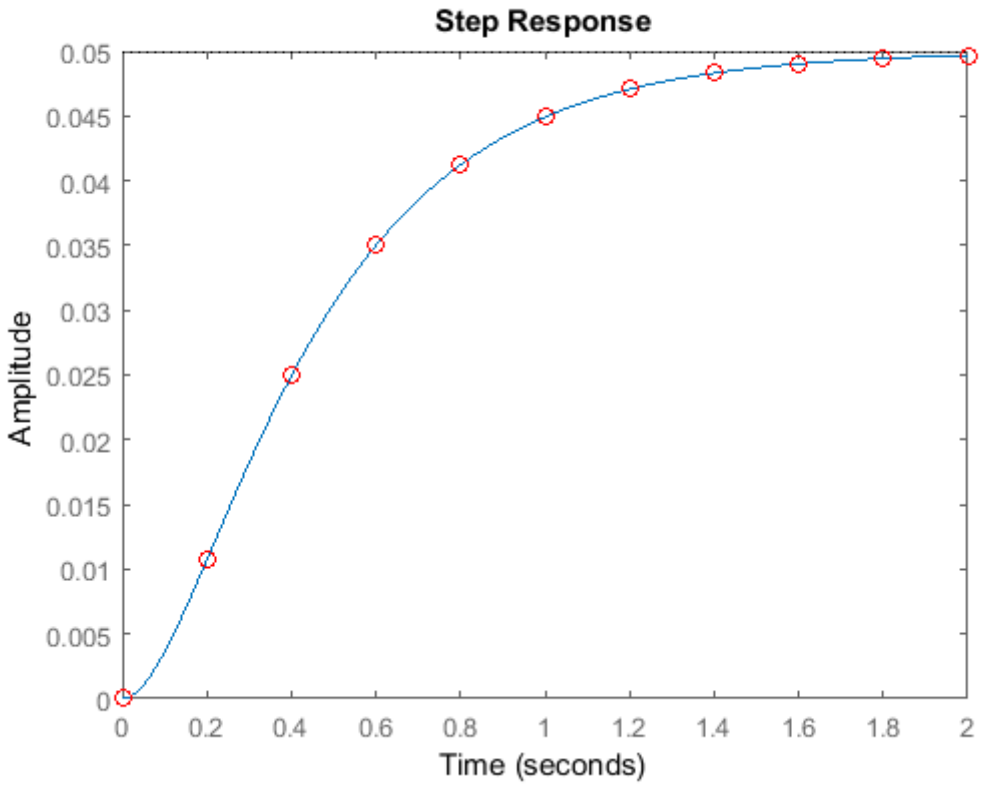
Control Tutorials for MATLAB and Simulink

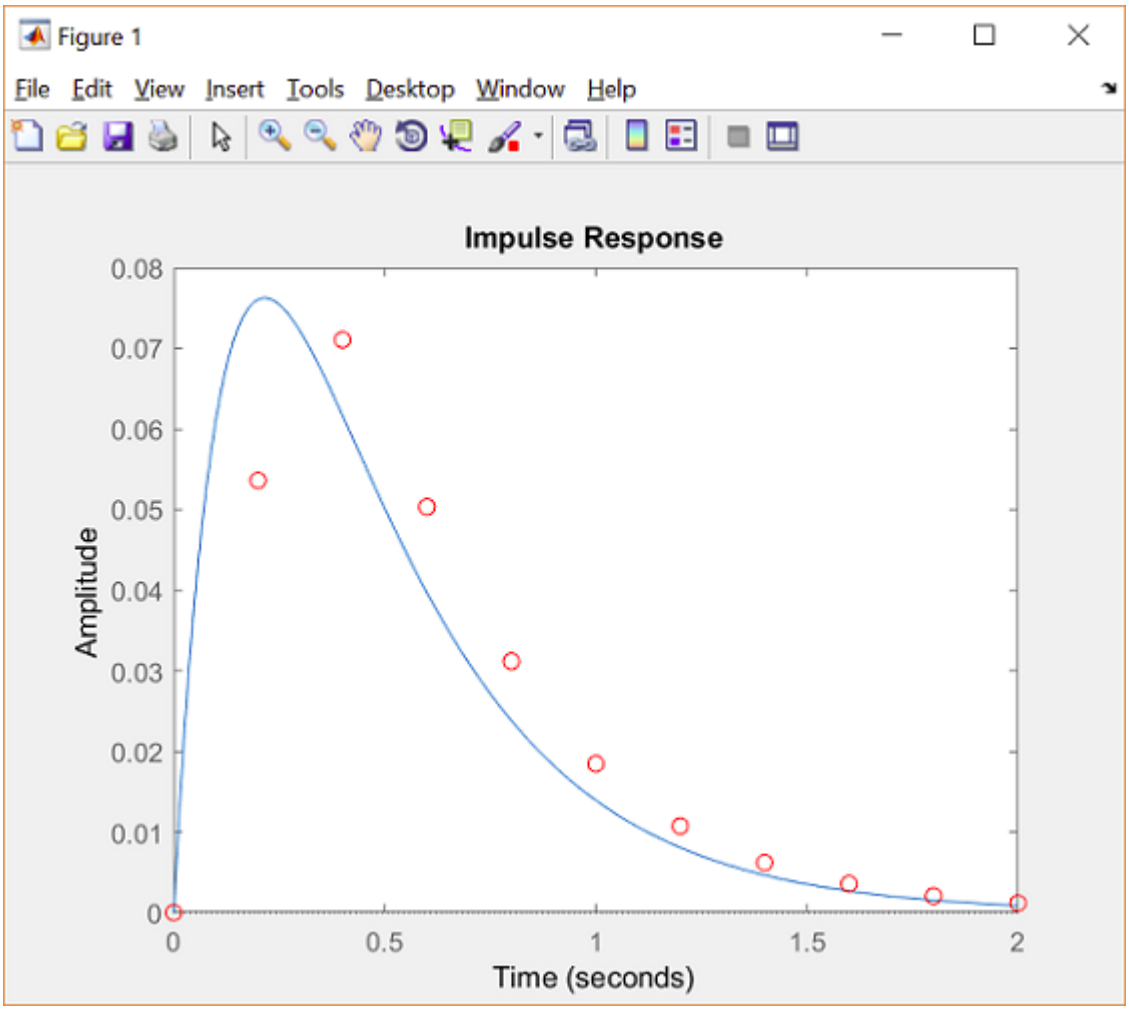
It should be noted that the single most important impact of implementing a control system digitally is the lagging effect associated with the hold. First, copy the following commands to an m-file and run it in the MATLAB command window.

```
s = tf('s');
sys = 1/(s^2+10*s+20);

Ts=0.2;
sys_d = c2d(sys,Ts);

step(sys,2)
hold on
[x,t]=step(sys_d,2);
plot(t,x,'ro')
hold off
```



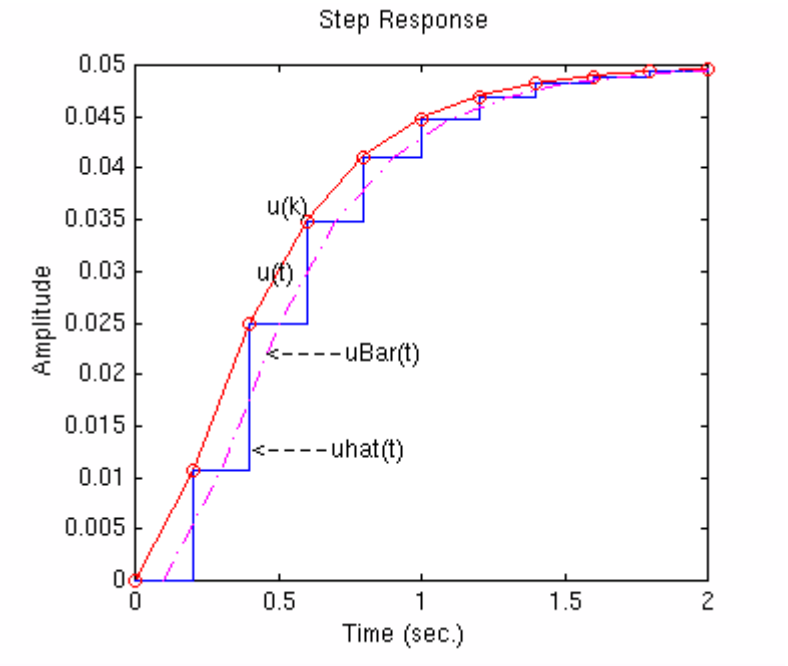
From this plot, we see that the discrete response exactly matches the continuous response at each instant of sampling time. This is true because the input was a **piecewise constant** step function. Had the input been a **continuously time-varying** function, it would not have matched exactly with the continuous response. This can be seen by changing the input of the same system from the example above from a step to an impulse. In the above m-file, change the `step` command to an `impulse` command. Re-running this m-file will generate the

following plot.



From this plot, you see the discrete output does not match the continuous output. The discrete response lags behind the continuous response over a certain range of time.

Even if the discrete response matches the continuous response at the sample times, as shown in the following figure,



the average signal `uBar(t)` lags the continuous signal `u(t)` by `Ts/2` seconds. However, if you decrease the sampling time (`Ts`, in sec/sample), this lagging effect becomes smaller and `uBar(t)` will more closely match the continuous signal `u(t)`.