**ME424 Project 3 Report**

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1. **solution:**

Knowing that 

then 

where 

1. **solution:**



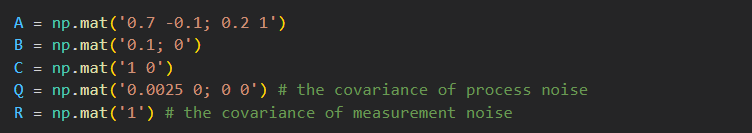
where 



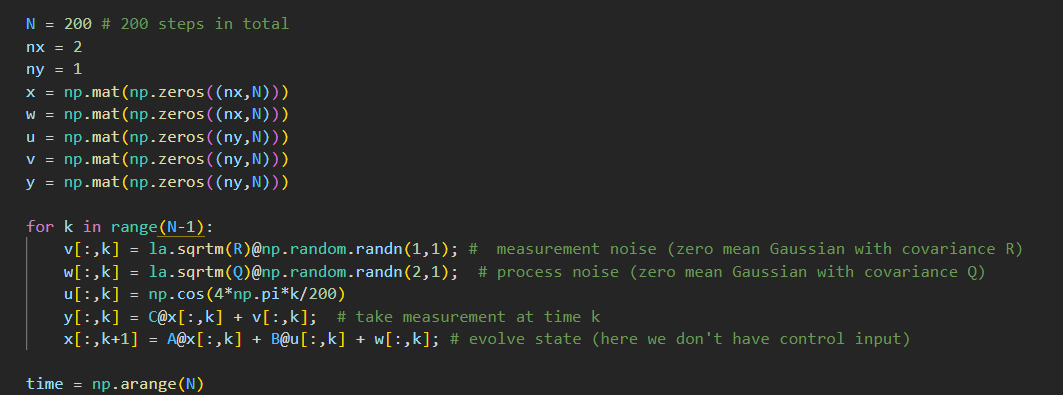
1. **solution:**
2. First define the system



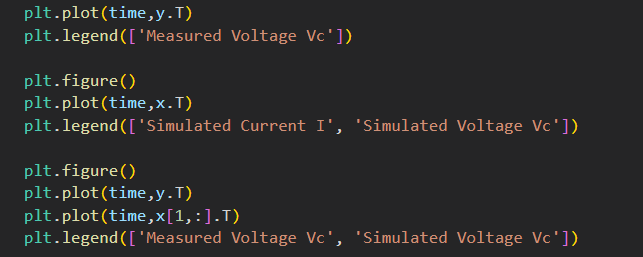
where 

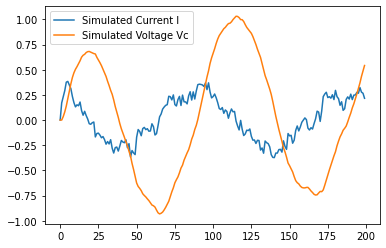


1. Second, start the simulation process in N = 200 steps in total

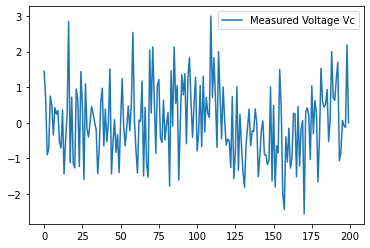


1. Third, save the result as ground truth and plot them as comparison

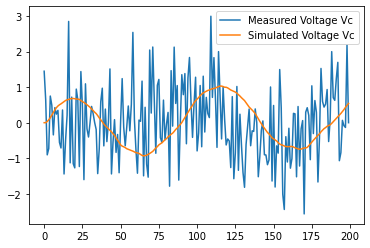




**figure 1: the plotting of *xk* (simulated current & simulated voltage)**



**figure 2: the plotting of *yk* (Measured voltage)**

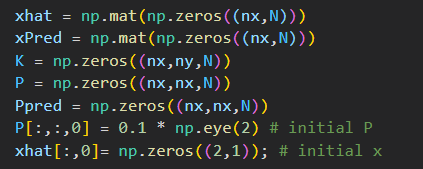


**figure 3: the comparison of *xk,2* & *yk* (simulated voltage & measured voltage)**

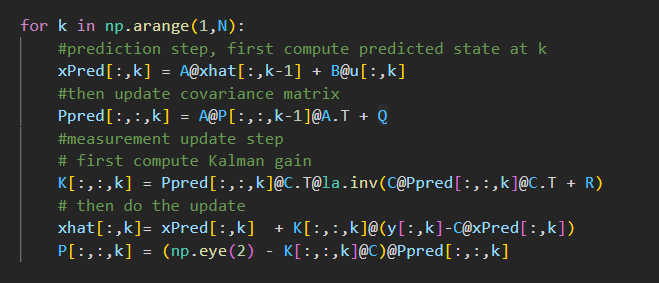
1. Implement of the Kalman Filter

solution:

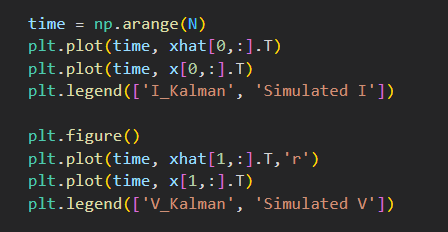


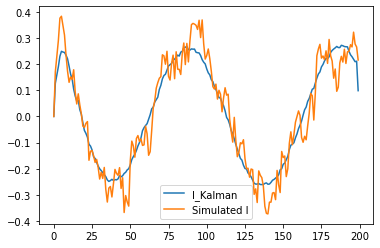


The simulation process with Kalman Filter:

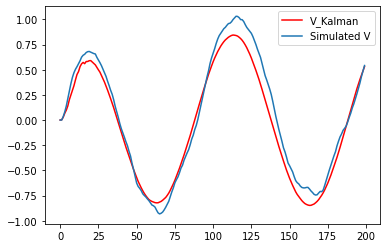


The code of the plotting of the result:



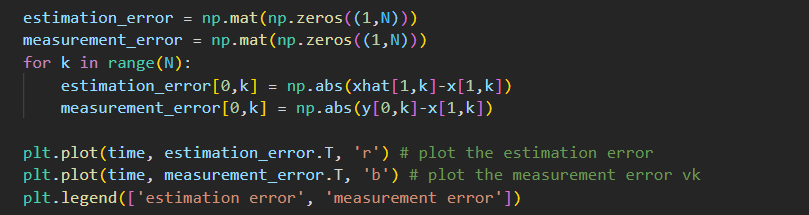


**figure 4: the plotting of estimated current & simulated current**

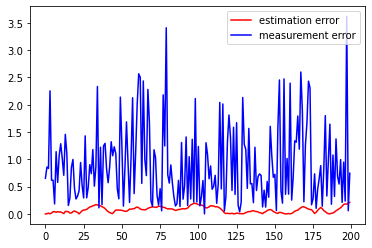


**figure 5: the plotting of estimated voltage & simulated voltage**

Compute and plot the measurement error *vk* and estimation error (Here I used the **absolute value** to define the error):



The result is shown as below:



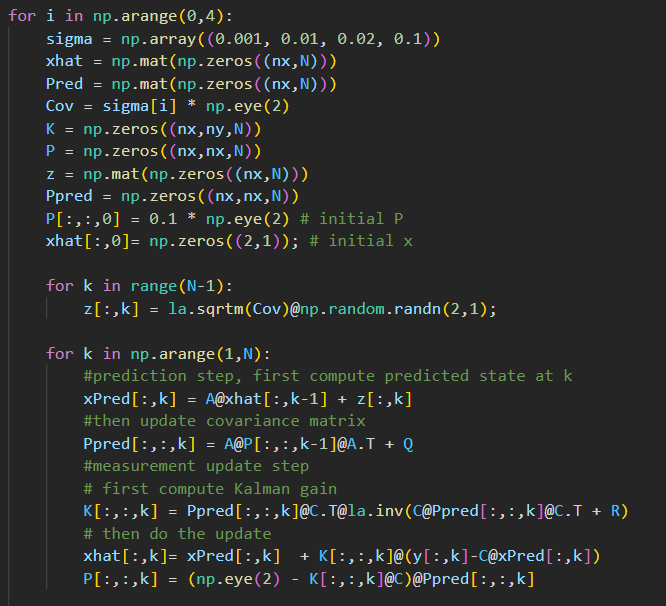
**figure 6: the plotting of estimation error & measurement error**

From the figure above we can see the result of the estimation error and the measurement error. We can see that **the measurement error without Kalman Filter is larger than the estimation error after Kalman Filter**, which shows that Kaiman Filter has the precision of estimate the data involving the measurement and the prediction.

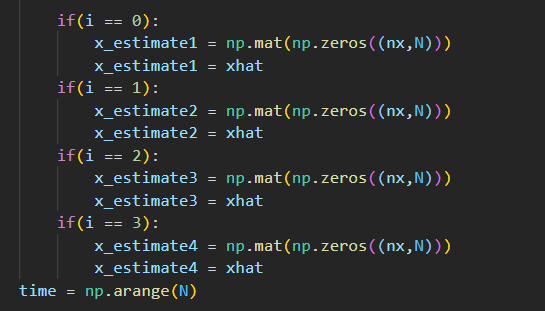
1. Modified Kalman Filter

solution:

1. Modify the Kalman Filter and add it into the new update model:

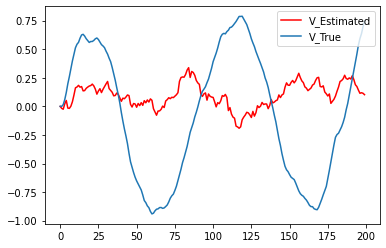


1. Store the value for = 0.001, 0.01, 0.02, 0.1



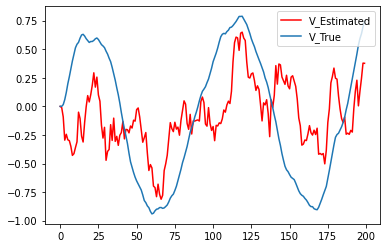
1. Plot the result

= 0.001



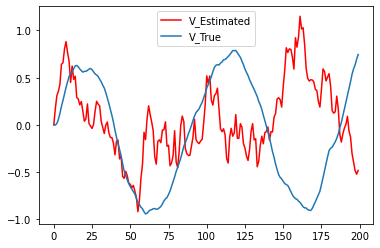
**figure 7: the plotting of estimation voltage & true voltage under = 0.001**

= 0.01



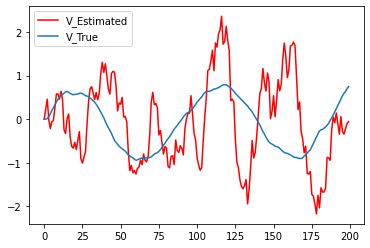
**figure 8: the plotting of estimation voltage & true voltage under = 0.01**

= 0.02



**figure 9: the plotting of estimation voltage & true voltage under = 0.02**

= 0.1

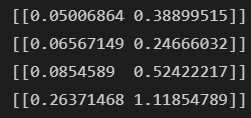


**figure 10: the plotting of estimation voltage & true voltage under = 0.1**

1. **compute the average squared error:**



The result is shown as below:



The first one is the average squared error of  **= 0.001**;

The second one is the average squared error of  **= 0.01**;

The third one is the average squared error of  **= 0.02**;

The last one is the average squared error of  **= 0.1**;

Explanation:

We can see that as grows, the value of the average squared error shows a increasing trend although there might be some fluctuation. Since is called scale parameter in the Gauss’ distribution, which defined the degree of the discretization of the Gauss’ distribution model with the data. As grows, the value of a larger input *zk* have a larger value more prospectively, which will cause a larger error.