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H-Infnitiy for world crude oil price estimation

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Abstract. In international or globalised trading, commodity trading does not only depend on the commodity, but also the role that companies have in commodity production and distribution. One step made by oil companies clearly determine the world oil prices associated with oil deposits (inventory) and drilling. The strategy they adopt in production will also be have strong effects on the world oil price trends. To observe the fluctuation of the world oil prices, an effort shall be made by estimating the world crude oil prices so that entrepreneurs can predict when the world oil prices fall or rise and determine policies in the production and use of oil. This study was to aplly method of the world crude oil price estimation, namely H-Infinity to determine the right decision the oil entrepreneurs shall make regarding the world crude oil. The simulation results showed that the application the H-Infinity method had an accuracy of around 97-98%.

1. Introduction

New inventions related to oil exploration, such as the development of fracking methods to obtain Shale oil, will tend to reduce oil prices. Likewise, the discovery of new oil reserves and the expansion of oil exploration by multinational oil companies will also lead to lower oil prices. This is due to such new inventions and discoveries which open up opportunities for increased oil supply in the future [1].

In this case, the development of new technology allows lower costs of exploration, production costs, and distribution, and these also lead to lower world oil prices. This is especially true if such practices are widely applied by oil companies. Also included in this category, biofuel studies and other materials having the potential to substitute petroleum as the world's main energy source will drive oil prices lower because future oil demand is projected to go down [2].

In general, the price of world oil as a commodity is determined by demand and supply. Factors contributing both of these will affect the world oil prices, in both short and long terms. Although these factors cannot be easily measured easily due a global market with a lot of uncertainty, estimates can be made by observing the latest development. In addition, it should be noted also that such a market is vulnerable to speculators and price games. Several factors affecting oil prices include oil stock, supplies from OPEC and non-OPEC member countries, the value of the US dollar, weather and geoplitics,

To analyze the fluctuation of oil prices, a proper effort shall be made by estimating world crude oil prices so that the consortium of oil entrepreneurs can predict when world oil prices fall or rise and determine policies in production, then reduce the causes of the problem that occur due to oil price

instability. Many studies on estimation are carried out in all scientific fields, including estimation of stock price [3,4], estimation of profit company [5,6], and estimation of AUV and ASV position[7,8,9], For that end, this paper applied the method of estimating world crude oil prices by H-infinty to determine the right decision or action the oil entrepreneurs shall make regarding the world crude oil.

2. H-infinity Algorithm

The algorithm H-infinty can be seen [10]:

Table 1. H-infinty Algorithm

Model system and measurement model
$x_k = A_k x_{k-1} + C_{b,k}^n f_k^b dt + g^n dt$ $z_k = C_{n,k}^b v^n + v_{v,k} = C_{b,k}^n x_k + v_{v,k}$
Initialization $\hat{x}_0 = \bar{x}_0$ $P_0 = P_{x_0}$
Time Update   Estimation : $\hat{x}_{k-1}^+ + C_{b,k}^n f_k^b + g^n dt$ Error covariance : $P_k^- = P_{k-1}^+ + Q_{k-1}$
Measurement Update $\Gamma_k = \left[I - \gamma P_k^- + C_{b,k}^n R_k^- C_{n,k}^b P_k^-\right]^{-1}$ *Kalman Gain* : $K_k = P_k^- \Gamma_k C_{b,k}^n R_k^{-1}$ Estimation : $\hat{x}_k^+ = \hat{x}_k^- + K_k\left(z_k - C_{n,k}^b \hat{x}_k^-\right)$ Error covariance : $P_k^+ = P_k^- \Gamma_k$

3. Simulation Result

This simulation of the application of the H-infinity algorithms to the crude oil functions with Matlab, obtained from Mathematical software simulation showed the oil crude data in Table 2. The simulation results were evaluated and compared to the established oil crude functions, and the crude oil price functions in equation (1) are as follows:

$$f(x) = 63{,}2x^2 - 755{,}12x + 1289$$

$$f'(x) = 126{,}4x - 755{,}12 \quad (1)$$

Due to the system requires discretion, so the crude oil functions model in equation (1) are discreted using the finite difference method. The change of state variables in respect to the time is approximated by forward scheme of finite difference. Then we get the following.

$$f' = \frac{df}{dt} \approx \frac{f_{k+1} - f_k}{\Delta t} \quad (2)$$

from equations (1) and (2), the modified the oil crude functions model in (3) is obtained as follows:

$$f_{k+1} = (126{,}4x_k - 755{,}12)\Delta t \quad (3)$$

Data of the World Crude Oil Prices are as follows:

Table 2. Data of the world crude oil prices

No	*Trade Date*	*Price*	No	*Trade Date*	*Price*
1	1 Oct 2017	75.46	31	7 Nov 2017	76.36
2	2 Oct 2017	76.59	32	9 Nov 2017	74.40
3	4 Oct 2017	75.75	33	10 Nov 2017	73.96
4	5 Oct 2017	74.12	34	11 Nov 2017	77.79
5	6 Oct 2017	77.96	35	12 Nov 2017	75.65
6	7 Oct 2017	76,92	36	13 Nov 2017	74.89
7	8 Oct 2017	73.55	37	14 Nov 2017	75.15
8	10 Oct 2017	74.21	38	16 Nov 2017	74.09
9	11 Oct 2017	74.37	39	17 Nov 2017	73.83
10	12 Oct 2017	757.43	40	18 Nov 2017	77.61
11	13 Oct 2017	75.08	41	19 Nov 2017	75.23
12	15 Oct 2017	76.42	42	21 Nov 2017	75.20
13	16 Oct 2017	77.75	43	22 Nov 2017	76.24
14	17 Oct 2017	75.15	44	23 Nov 2017	75.69
15	18 Oct 2017	75.88	45	24 Nov 2017	76.96
16	19 Oct 2017	74.58	46	25 Nov 2017	77.78
17	21 Oct 2017	74.37	47	26 Nov 2017	76.22
18	22 Oct 2017	73.66	48	28 Nov 2017	74.04
19	23 Oct 2017	76.86	49	29 Nov 2017	75.73
20	24 Oct 2017	75.93	50	31 Nov 2017	77.5
21	25 Oct 2017	77.20	51	2 Dec 2017	73.24
22	27 Oct 2017	76.11	52	4 Dec 2017	75.03
23	28 Oct 2017	75.01	53	6 Dec 2017	74.15
24	29 Oct 2017	74.85	54	7 Dec 2017	75.70
25	30 Oct 2017	73.34	55	8 Dec 2017	76.59
26	1 Nov 2017	75.46	56	9 Dec 2017	77.08
27	2 Nov 2017	73.57	57	11 Dec 2017	76.67
28	3 Nov 2017	72.93	58	12 Dec 2017	74.52
29	5 Nov 2017	73.73	59	13 Dec 2017	75.63
30	6 Nov 2017	75.92	60	14 Dec 2017	76.37

In this study a simulation was carried out by applying the H-infinity algorithms to the function of crude oil. The simulation results were evaluated by comparing the real conditions in the field with those of the results of H-infinity estimates. This simulation used $\Delta t = 0.1$ and 500 iterations and generated 750 and 1000 iterations. Figure 1 is a comparison of the estimated results of H-infinity and those of 500 iterartion. Figure 2 is the result of the simulation of the H-infinity method using 750 iterations.. Figure 3 is a simulation of the H-infinity method using 1000 iterations.

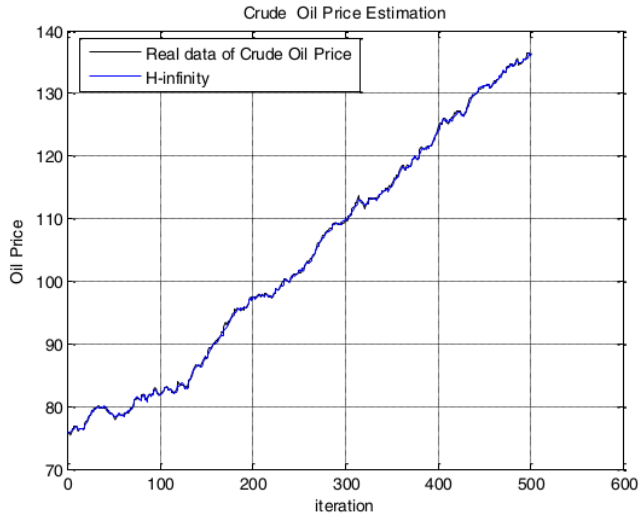

Figure 1. Estimation of crude oil prices using H-Infinity with 500 iterations

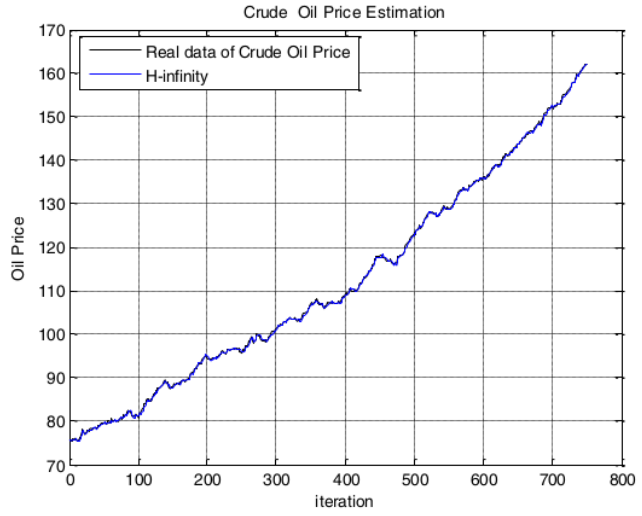

Figure 2. Estimation of crude oil prices using H-Infinity with 750 iterations

Figure 1 shows that the estimated crude oil price has a pattern that is almost the same as the price of real crude oil, where the estimated crude oil price using the H-infinity method with 1000 iterations has high accuracy with an error of less than 2,5%, and RMSE of 0.00207. However, the estimation results using the H-infinity method with 750 iterations in figure 2, have a considerable error of around 4% with RMSE of

0.00672. In Table 2, it appears that the H-infinity method by generating 750 iterations has higher accuracy than that by generating 500 iterations. if seen from the graph in figure 1 -3, it appears that oil prices will increase maybe one of the factors is due to the increasing demand and use of oil

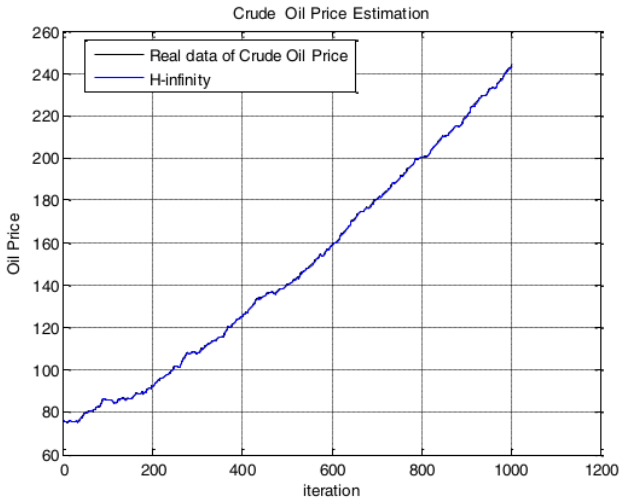

Figure 3. Estimation of crude oil prices using H-Infinity with 1000 iterations

In Figure 3, it appears that the H-infinity method with 1000 iterations has higher accuracy than 500 and 750 iterartions method. In Table 2, it appears that the H-infinity method by generating 1000 iterations has higher accuracy than that by generating 500 and 750 iterations, because in this case the number of iterations generated also affects accuracy. in general the H-infinity method can be effectrively used as a method to estimate crude oil prices with fairly good accuracy

Table 3. Comparison of the RMSE values by the H-infinity based on 500, 750 and 100 iteration

	500 Iteration	**750 Iteration**	**1000 Iteration**
RMSE	0.00847	0.00672	0.00207
Simulation Time	6,288 s	8,595s	10,881 s

4. Conclusion

Based on the results of the simulation analysis with matlab, in general the H-infinity method can be effectrively used as a method to estimate crude oil prices with fairly good accuracy. It could be concluded that the H-infinity methods could be applied to estimate crude oil functions with high accuracy for 500, 750 or 1000 iterations.

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