

# Unscented Kalman Filter and H-Infinity for Travel Company Stock Price Estimation

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## ABSTRACT

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### Keywords

Unscented Kalman Filter;  
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The travel and hotel industry is one of the industries experiencing rapid growth. As the population grows, the need for travel and accommodation services gets higher. This is one of the factors contributing a rapid increase in such service industry. Competition in the economy and business world is getting tougher from year to year both within a country and abroad. Considering that Indonesia is a country comprised of many islands with a variety of natural beauty, it has the very potential for tourist resort attraction. This kind of thing leads to the growth of the Hotel and Travel industry to support tourism development. With such rapid service industry development, supported by promising business opportunities, investors for such sector are encouraged. The right way to reduce risk for investors interested is to develop a system for estimating the stock prices. Therefore, in this study, the stock price estimation method applied for travel companies adopted Advanced Kalman Filter, a comparison of H-Infinity and Unscented Kalman Filter (UKF) as a chart for investors to take into consideration in their investment decision making. The simulation results showed that the UKF method had higher accuracy than the H-Infinity method with an error by the UKF of 3.2% and that by the H-Infinity of 9.6%.



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## 1. Introduction

The Indonesia Stock Exchange is one of the government's initiative to encourage continual increase in the number of capital market investors in Indonesia because basically domestic investors play an important role to strengthen and maintain the stability of the Indonesian capital market [1]. The growth in the number of domestic investors accompanied by an increase in the number of transactions is expected to give direct economic benefits to the Indonesian people, including companies in the tourism and hotel sectors. Tourism is one of the most important factors contributing the income of an area. To attract tourists, several supporting factors are required, one of which is a travel manager. The tourism sector is a very important service-based sector for Indonesia. Natural wealth is an important component in the world of tourism in Indonesia. With good management in the field of travel companies, it can increase foreign exchange earnings and regional income, as well as expand employment and business activities [2].

The hotel and travel industry is one of the industries experiencing rapid growth. As the population grows, the need for travel and accommodation services gets higher. To make a safe investment in the shares of tourism and travel companies, investors need a method to assess the stock prices of the travel companies for purchasing or to assess the ability of these shares to provide dividends in the future, so they can optimize profits by improving company performance [3]. The right analysis method to lower the risk for investors in investment making, one way to reduce risk is by applying an estimation algorithm to find out the estimated future stock prices.

Several studies, beside those on economics, applied estimation algorithms, among others, the application of estimation methods on tourism ships [4], and in the military field the application of estimation algorithms for AUV [5,6] and missile trajectory estimation to determine the trajectory to be followed by the vehicle [7]. Using the estimation algorithm similar to those applied by the above cases, in this study the stock price estimation method is used for travel companies by using Unscented Kalman Filter (UKF) and H-infinity methods as the basis of investor considerations for investment making.

## 2. Unscented Kalman Filter (UKF) and H-Infinity Algorithm

The UKF algorithm can be seen in Figure 1 and H-infinity algorithm can be seen in Figure 2.

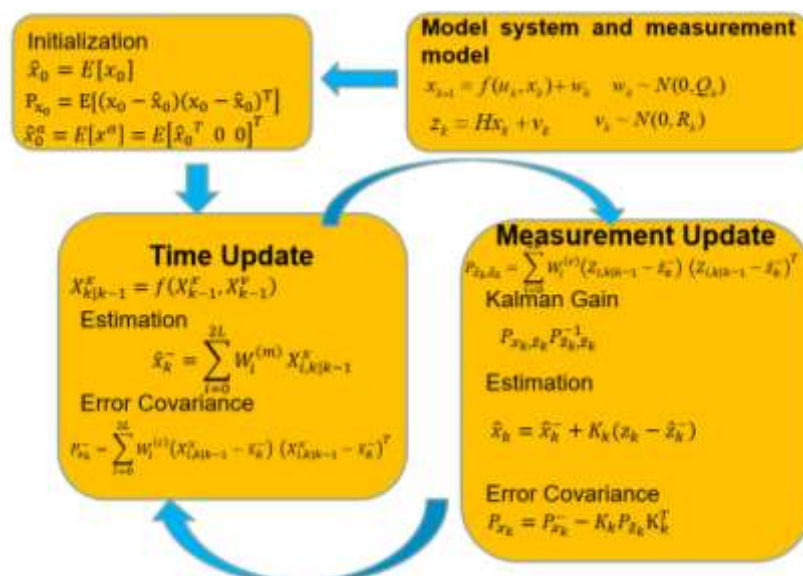


Figure 1. Unscented Kalman Filter Algorithm [8,9]

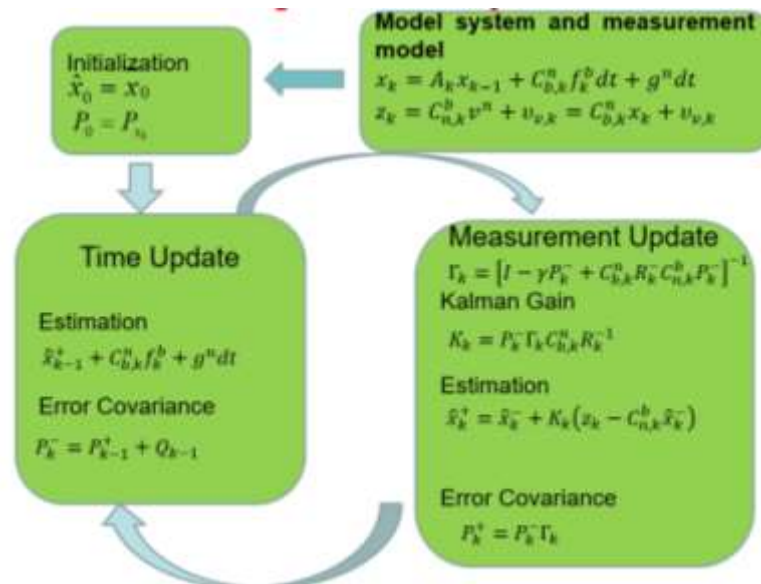


Figure 2. H-infinity Algorithm [10]

In Figure 1 and 2 describe the flowchart of UKF and H-Infinity algorithm, the implementation of UKF and H0infinity algorithm step include Initialization Step, Prediction step or time update, and correction step or measurement update. And in this paper UKF and H-Infinity algorithm for estimation algorithm on the stock price function of the travel company.

### 3. Simulation Result

The application of the two estimation algorithms, that is, the UKF and H-infinity algorithms on the stock price function of the travel company data in Table 1 for the close price by running the Mathematica software listed in equations (1) to produce the estimated close price offer of the herbal medicine company's stock. Here are the functions of travel company's stock:

$$\begin{aligned}
 g(x) &= -0,0264813x^2 + 0.0614239x + 151,16 \\
 g'(x) &= -0.0529626x + 0.0614239
 \end{aligned}
 \tag{1}$$

With x is month

Table 1. Close Stock Price of Eka Sari Lorena Transport Company

Month	Closing Price			
	2015	2016	2017	2018
Jan	188	113	189	95
Feb	140	105	145	98
Mar	150	110	187	103
Apr	137	111	178	112
May	164	110	138	97
June	271	125	130	106
July	160	150	127	104
Aug	122	118	127	103
Sept	120	140	105	103
Oct	119	184	96	98
Nov	113	187	97	103
Dec	122	220	94	107

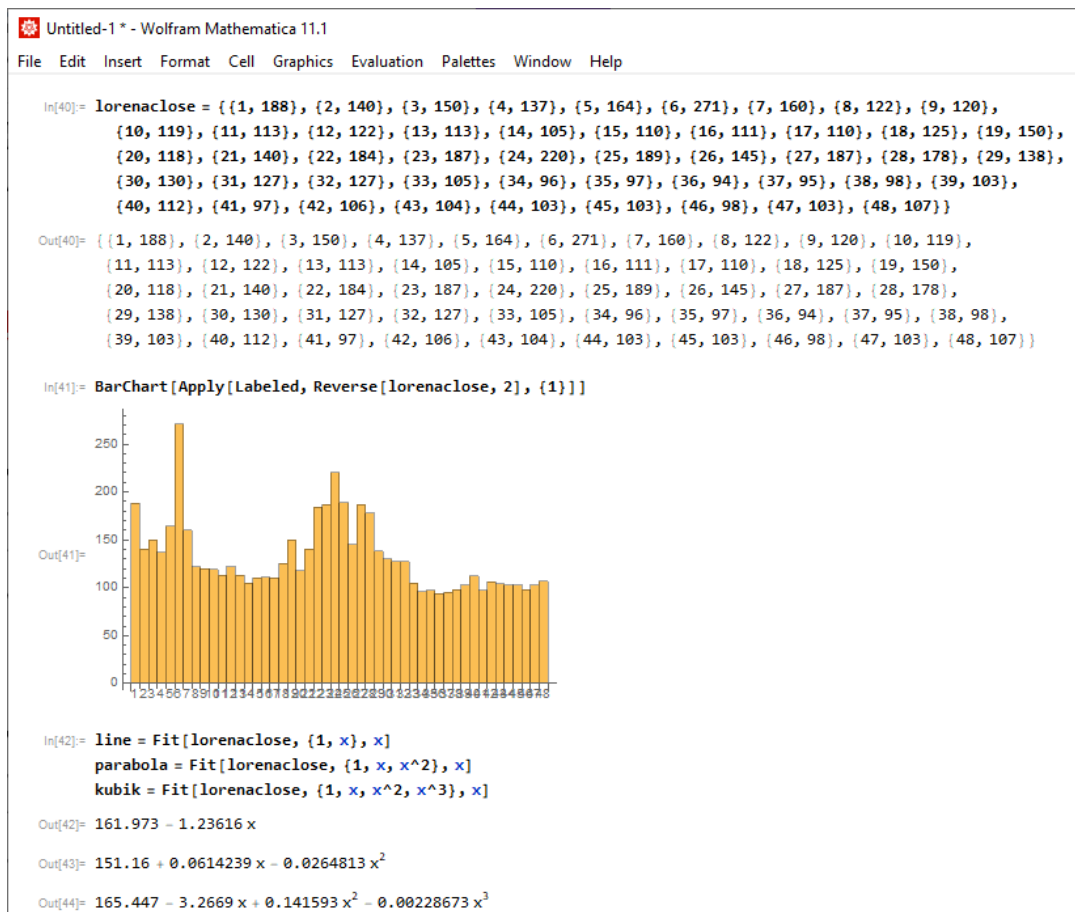


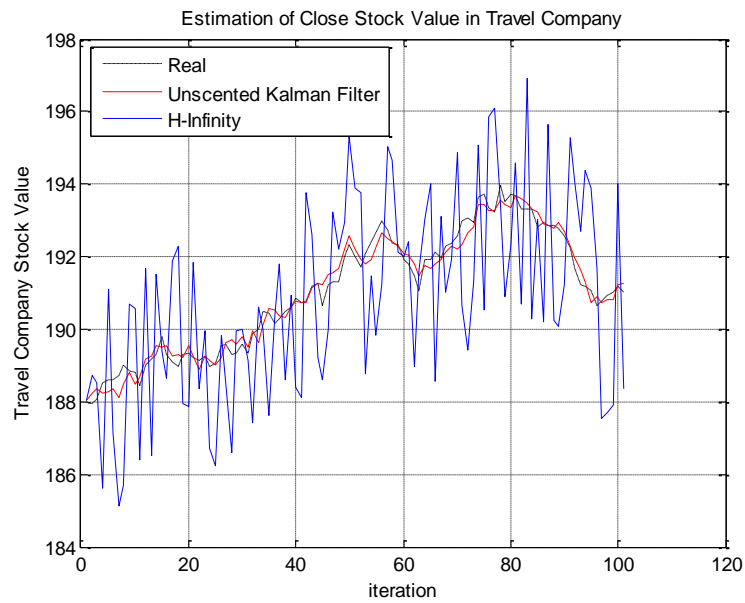
Figure 3. Simulation Travel company's stock using Mathematica Software

From Equation (1), the function of travel company's stock is discretized through a discretization process so that Equation (2) is obtained.

$$g_{k+1} = (-0.0529626x_k + 0.0614239)\Delta \tag{2}$$

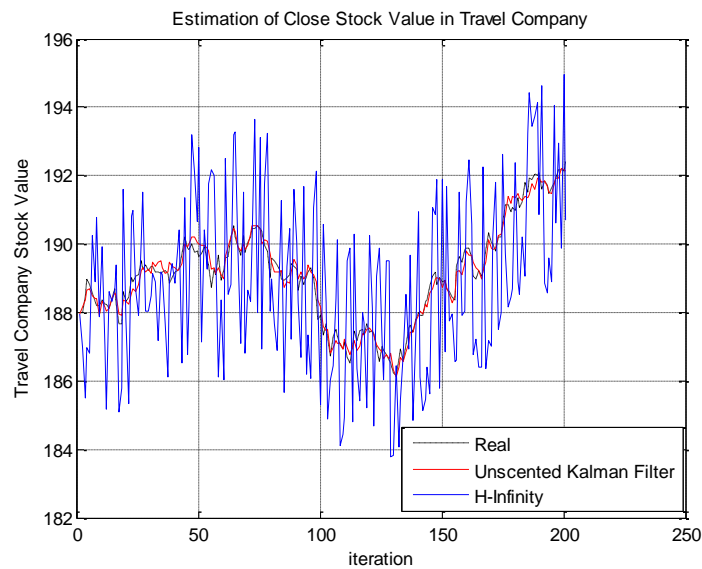
The implementation of the UKF and H-infinity algorithm on the close stock price functions resulted from running the Mathematica software seen in Equations (1) is to produce the close price estimates for a Eka Sari Lorena Transport company's share.

The purpose of this paper is to compare numerical simulation results by the H-infinity and UKF algorithms with 100, 200 and 300 iterations to estimate close stock prices. This was conducted as an preliminary study to determine the stability of stock prices that are likely to rise or fall.



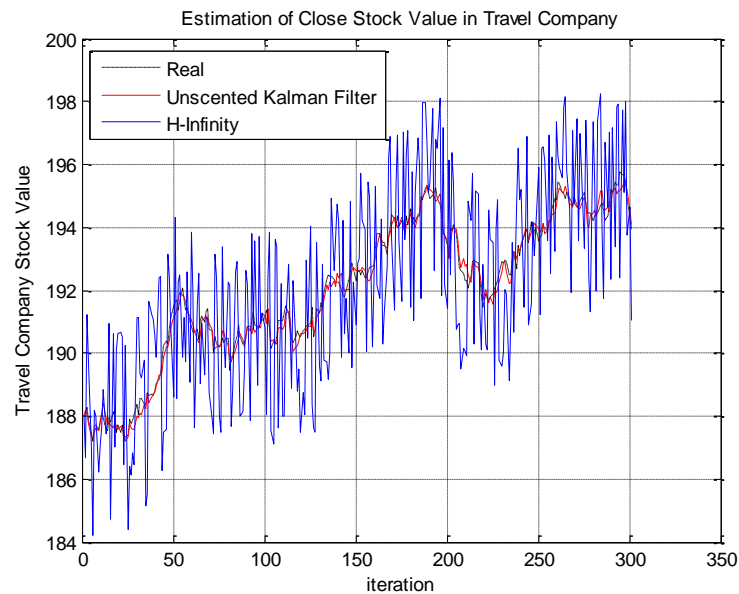
**Figure 4.** Estimation of Travel Company’s close stock price using UKF and H-Infinity with 100 iteration

This UKF method is a special algorithm for linear and nonlinear models and is compatible with the close herbal stock function in Equation (1), while the H-infinity method is an estimation method that can be used for linear and nonlinear models, but is more often used for nonlinear models. However, in this paper, the author attempted to use the H-infinity method to determine its reliability when used in a linear model.



**Figure 5.** Estimation of Travel Company’s close stock price using UKF and H-Infinity with 200 iteration

Figures 4 and 5 illustrate the results of the estimated close stock price of Eka Sari Lorena Transport companies by using 100 and 200 iterations. It can be seen that the EKF algorithm could produce a small error of around 2.4%, this could also be observed in the comparison of errors in Table 2, whereas the error resulting from H-infinity was around 7.5%.



**Figure 6.** Estimation of Travel Company's close stock price using UKF and H-Infinity with 300 iteration

Likewise in Figure 6, it shows that the UKF algorithm is more accurate than the H-Infinity one, and with 300 iterations it could be applied to estimate the close stock prices as in Table 2, indicating that the more looping iterations, the smaller the error. So, it can be said that the estimation method for the linear model was effective if applied to the linear model, but for the method specializing in the non-linear model, it was suggested to use the nonlinear model.

#### 4. Conclusions

Based on the results of the simulation analysis, the results of estimated close price stock using UKF have good accuracy with an error of less than 2.4%. Overall, the UKF method can be used as a method to estimate stock prices of Eka Sari Lorena Transport for close prices with very good accuracy.

**Open Problem.** How to implemented Particle Filter for estimation of price stock in travel company

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