Research on image saliency target detection in fog and haze weather based on improved FT algorithm

Shanshan Huang*
Central China Normal University Wollongong Joint Institute, Wuhan, China

*Corresponding author e-mail: huangss981115@163.com

Abstract. The increase of air turbidity in fog and haze weather is not conducive to the accurate extraction of image feature information of important salient targets such as vehicles and pedestrians, nor is it conducive for drivers to make correct judgment on the road environment ahead of their vision. Therefore, this paper proposes an improved FT algorithm in fog and haze weather. This algorithm firstly uses the Retinex algorithm to remove fog and haze and restore color of fog and haze weather images, then uses FT algorithm to detect the saliency of the target, and finally completes the simulation based on MATLAB platform. It can be seen from the simulation results that the improved FT algorithm is significantly better than the effect of using the traditional FT algorithm, which means that the improved FT algorithm has a better role in helping drivers to detect road salient targets in fog and haze weather. And this improvement has a strong practical value for reducing the incidence of traffic accidents in fog and haze weather.

1. Introduction
Fog is an aerosol system composed of a large number of tiny water droplets or ice crystals suspended in the air near the ground. Its presence reduces the transparency of the air and makes visibility worse. Haze is composed of dust, sulfuric acid, nitric acid, organic hydrocarbons and other particles in the air, its existence can also make the atmosphere turbidity, blurred vision, visibility deterioration. Therefore, the air turbidity caused by fog and haze is not conducive for drivers to make a correct judgment on the driving environment ahead, which is easy to form a large safety hazard.

In the field of intelligent transport, Itti et al. [1] proposed a visual attention detection model based on saliency around 1998. The idea is to simulate the visual perception mechanism of human beings, calculate the saliency of regional information received by human vision, and finally quickly find the target to be tested. This technology can assist drivers to judge and make decisions on road conditions, and help drivers to find targets such as vehicles and pedestrians in front in a timely manner, thus reducing the incidence of traffic accidents [2]. However, mainstream algorithms in this field, such as FT[3], ITTI[1], LC[4], SR [5], all rely on the color information of images. On the other hand, images in fog and haze weather are mostly affected by the environment, with dark or even seriously faded colors, which will have a serious impact on the accuracy of detection results of image saliency targets.

To solve this problem, this paper proposes an improved image saliency target detection algorithm, which combines the Retinex algorithm in traditional image enhancement technology with the frequency-tuned FT algorithm in saliency detection, so as to effectively improve the accuracy of image saliency target detection results in fog and haze weather.
2. **Retinex algorithm processing process based on fog and haze weather image**

Retinex algorithm is widely used in the field of image enhancement. It can enhance the surrounding contour of the image, and also keep the color clarity and saturation of the image stable, etc. Especially in the image processing of fog and haze removal, Retinex algorithm can effectively restore the original image color of fog and haze image. Retinex algorithm is implemented on the MATLAB platform as follows:

1. Input a color RGB image file and obtain the color components of R, G and B channels of the image after the computer reads it;
2. Convert the above three channel components into integer data and double precision floating point data, and then convert them to logarithmic domain to obtain the three channel components of the original image in logarithmic form;
3. Fourier transform the result of step (2);
4. By defining the standard deviation of Gaussian template and the size of Gaussian template, three Gaussian filtering functions of double-precision floating point matrix are constructed respectively;
5. Fourier transform the Gaussian filtering function;
6. Convolve the results of step (5) with the R, G and B components of step (1) respectively (i.e., carry out low-pass filtering on the original image), and invert Fourier transform of the filtered three components;
7. Transform the result of step (6) to the logarithmic domain, and carry out the difference operation between the three-channel component of step (1) and the result after the convolution operation of step (6) to obtain the three channel components of the image with high frequency enhancement;
8. Perform exponential operation on the results of step (7) to obtain the three components of the enhanced image;
9. Carry out contrast enhancement processing for the enhanced image components;
10. Overlay the three components into a three-dimensional RGB image to display the results.

3. **FT algorithm processing process based on image saliency detection in fog and haze weather**

As one of the spatial frequency-domain analysis algorithms, FT algorithm is more efficient and easier to realize saliency detection. Compared with SR algorithm, FT algorithm can retain more high-frequency information and clearer saliency target boundary [6]. The realization process of FT algorithm on MATLAB is as follows:

1. Input a color RGB image file, and then use imread function to read;
2. Gaussian filtering with core of 3*3 was performed on the original image;
3. Convert the result of step (2) to color space;
4. Extract the three channel components of the result of step (3), l, a and b, and conduct arithmetic mean operation;
5. According to formula $S_{FT}(x,y)=\parallel I_c(x,y)-I_{Whc}(x,y)\parallel$, calculate the Euclidean distance between the mean image and the result of step (4), and get the saliency value of the original image;
6. Simplify the calculation of saliency value to obtain the desired saliency image.

4. **Image saliency target detection in fog and haze weather based on improved FT algorithm**

4.1 **An improved FT algorithm combined with Retinex algorithm.** Affected by fog and haze weather, most of the images in fog and haze weather are dim or even seriously pale, while most of the saliency detection algorithms require high color integrity of the original image, so it will be a great challenge. In order to solve this problem, this paper improves the FT algorithm of the traditional saliency detection model and combines it with the Retinex algorithm to obtain an
improved image saliency target detection algorithm. The basic steps of algorithm implementation are shown in Figure 1(a)-(c).

![Input original image](image1)

(a) Input original image

![Retinex algorithm is used to remove fog and haze and enhance](image2)

(b) Retinex algorithm is used to remove fog and haze and enhance

![Image saliency detection of FT algorithm](image3)

(c) Image saliency detection of FT algorithm

**Figure 1.** Steps of the improved FT algorithm

4.2 Simulation results and analysis. The simulation equipment is 64 dual-core CPU i7 quad-core PC, and the programming environment is MATLAB R2016a. The images selected for simulation are all natural images related to fog and haze weather in Baidu gallery. In this paper, three typical images are selected from these natural image databases, and the traditional FT algorithm and the improved FT algorithm are used to detect the image saliency target respectively. The effect comparison diagrams are shown in Figures 2-4, respectively.

It can be seen from Figure 2 that for the original image in fog and haze weather, the saliency image directly using traditional FT algorithm can only roughly see the cars parked on the square, and the ground square area has low pixels and much miscellaneous information. In the saliency image of the improved FT algorithm, the pixel of the ground square area is increased, the background miscellaneous information is reduced, and the edge of the saliency area is clearer.
Figure 2. Example 1 of improved FT algorithm simulation

It can be seen from Figure 3 that for the original image in fog and haze weather, the saliency area center contrast of the saliency image directly using traditional FT algorithm is low, and the saliency target (female cyclist) is not obvious. The saliency region center contrast of the improved FT algorithm is higher, and the saliency target (female cyclist) is more prominent.
Figure 3. Example 2 of improved FT algorithm simulation

It can be seen from Figure 4 that for the original image in fog and haze weather, the saliency region brightness of the saliency image directly using traditional FT algorithm is low, and the target to be measured (street lamp, pedestrian) is not obvious. The saliency region brightness of the saliency image of the improved FT algorithm is higher, and the saliency targets (street lamps and pedestrians) are more prominent.
In short, the improved FT algorithm has richer edge information, and also improves the brightness and central contrast of saliency areas, so the simulation effect is more in line with the human visual perception mechanism. Compared with the traditional FT algorithm, the improved FT algorithm has higher accuracy and more obvious saliency in detecting the target in fog and haze weather.

5. Conclusions
Aiming at the defects of image saliency target detection in fog and haze weather, this paper combines the traditional FT algorithm with the Retinex algorithm in the field of image enhancement to improve the traditional FT algorithm, and completes the simulation of image saliency target detection in fog and haze weather based on the MATLAB platform. The simulation results show that the improved FT algorithm can significantly improve the detection effect of image saliency in fog and haze weather, can help drivers to effectively identify the front target in fog and haze weather, and has practical value for the application of image saliency target detection in the field of intelligent traffic. However, as the simulation in this paper is based on the assumption that fog and haze distribution is uniform, the detection effect of this algorithm in areas with different concentrations of fog and haze in real life remains to be observed and improved.

6. Acknowledgments
Thanks for the guidance from associate professor Meng Yanli, School of Physics, Northeast Normal University.

References
[1] L. Itti, C. Koch, E. Niebur, A model of saliency-based visual attention for rapid scene analysis, IEEE T. Pattern Anal. 20(1998) 1254-1259.
[2] K. Liu, X.Y. Zhang, N.J. Chen, X.P. Su, Salient object detection fusing depth information under foggy weather, J. Hebei Univ. Technol. 44(2015) 10-15. (in Chinese)
[3] H.R. Wilson, D.J. Gelb, Modified line-element theory for spatial-frequency and width discrimination, J. Opt. Soc. Am. A, 1(1984): 124-131.
[4] F.S. Frome, S.L. Buck, R.M. Boynton, Visibility of borders: separate and combined effects of color differences, luminance contrast, and luminance level, J. Opt. Soc. Am. 71(1981) 145-150.
[5] C.L. Guo, L.M. Zhang, A novel multiresolution spatiotemporal saliency detection model and its application in image and video compression, IEEE T. Image Process. 19(2010) 185-198.
[6] L. Huang, The application study of natural image based on improved FT algorithm, Microcomputers Appl. 34(2015) 37-39. (in Chinese)