The visual distance of industrial cameras varies with exposure time during blowing snow

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EXTENDED ABSTRACT

Poor visibility during blowing snow can cause a chain-reaction and sometimes resulted in traffic fatalities. Therefore, an accurate understanding of visibility during blowing snow is important to provide drivers with safe traffic and road administrators with accurate road traffic information. Our latest study constructed a fundamental model regarding the visibility in blowing snow considering the suspended snow particles' afterimage. The afterimage is related to the visual duration and the model expressed well the visibility of the human eye (1). However, the fundamental model is not useful to provide drivers with safe traffic and road administrators with accurate road traffic information. Here we examine the visual distance of industrial cameras varying with exposure time during blowing snow in Hokkaido, Japan.

Two industrial cameras which we used were set on the windshield of the weather observation vehicle (Figure 1). The two cameras are for comparison of the difference in how a visual distance changes and how we see suspended blowing snow particles when we use different exposure times with each camera. The exposure time is related to the visual distance because the suspended snow particles' afterimages are identified and perceived as lines or tails.

In general, the exposure time of the video camera cannot be set manually, while the industrial camera (WAT-2400S, WATEC Co. Ltd.) which we used can set the exposure time arbitrarily. The frame rate of the industrial camera is fixed at 30 fps, and the exposure time is able to change from 0.04 to 3.9×10^{-5} seconds with an electrical frequency of 50 Hz. The camera can change the white balance and backlight compensation but the configurations are set automatically or we used them as the default.

The results show that the shorter the exposure time of the industrial camera, the longer the visual distance. Figure 2 shows, for instance, images taken by the industrial cameras while driving the vehicle during blowing snow. The fixed-post delineators are lined up at the edge of the lane road. The delineators are 50m distant from each. The 1/6400 second image shows two delineators in front of the image at the left side of the lane edge, while the 1/25 second image shows the closer delineator but the distant delineator is unclear and the sight is blurred in the image of 1/25 second compared to the 1/6400 second image. The result suggests that monitoring blowing snow by using cameras with properly adjusted exposure times will provide accurate visibility information to road administrators and provide more clear sight with shorter exposure time on vehicle cameras to motorists. Furthermore, automated driving technology has made remarkable progress, and cameras and 3D laser range sensors are widely used to control vehicles. The perspective of the study is highly valuable for use in future automated driving technology.

REFERENCES

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Figure 1. Weather observation vehicle (lower image) and industrial cameras lined up on the windshield (upper image). An image of the industrial camera shows up-right corner of the upper image.

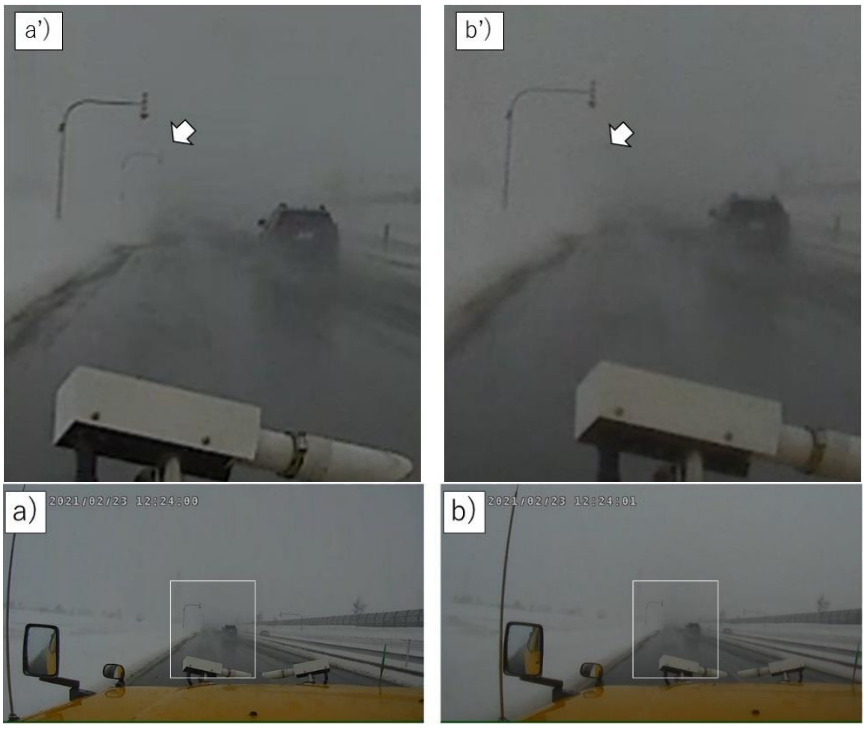

Figure 2. Captured images are taken by the industrial cameras lined up on the windshield of the weather observation vehicle. The exposure time is a) 1/6400 second and b) 1/25 second, respectively. a') and b') are enlarged images of the white frames in a) and b), respectively. The arrows in the figures indicate a fixed-post delineator located 50 m distant from the forefront delineator.