Seeing is NOT Believing :
A Object recognizing task-driven dehazing algorithm for autonomous vehicles

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초 록

There's been a lot of dehazing algorithms proposed, e.g. Dark Channel Prior, Color Attenuator Prior, Deep-neural-network based algorithms, etc. But these algorithms focus on the fidelity of images for humans, not computers, or a single task. In this paper, we suggest a simple dehazing algorithm based on Contrast-limited adaptive histogram equalization(CLAHE) and Dark Channel Prior(DCP) for the only object recognizing task under driving situations. As a result, our output images worked better with object recognizing algorithms, especially YOLO v3, than a single CLAHE or DCP, despite strong visual distortion.

연구의 필요성

Though LiDAR has been proposed for autonomous vehicles' eyes, because of its expensive cost and massive size, it has been rejected by manufacturing companies. Their car tends to depend on visual information captured by cameras. But the visual information is fragile to unusual conditions, like haze or fog, which can bring a terrible accident. Although there's plenty of dehazing algorithms, they focus on the human vision, not a single task, like object recognition. As B. Li(2015) [3] noted, 'such a "task-driven" evaluation way has received little attention so far, despite its great implications for outdoor applications.'

연구목표

Dense haze/fog is an important factor making driving seriously difficult, not only for humans but also for computers. In this paper, we focus on the dehazing algorithm based on Dark Channel Prior(DCP) which can outperform the others, in terms of object recognition. First, we made several assumptions about visual circumstances under haze/fog. As a result, we needed measures to improve t(transmission) values on DCP. We tested several means such as histogram equalization, a Contrast-Limited Adaptive Histogram Equalization (CLAHE), a Retinex, and an automated multi-scale Retinex(Auto). We measured how many objects were well-recognized for each.

연구내용

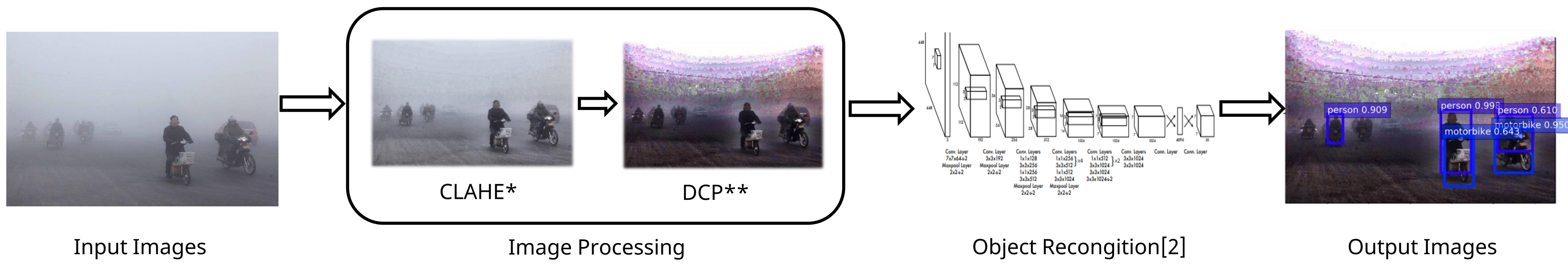

Figure1. Image processing algorithm we propose.

***Histogram Equalization(HE)** : HE is a method in image processing, which disperse flocked bars in an image histogram. It makes a better contrast on a vague image. CLAHE is an applied version of HE.

****Dark Channel Prior(DCP)** : DCP is a best-known dehazing algorithm, utilizing the fact that there is at least one color channel with a fairly low value in a pixel of haze-free image.

연구결과

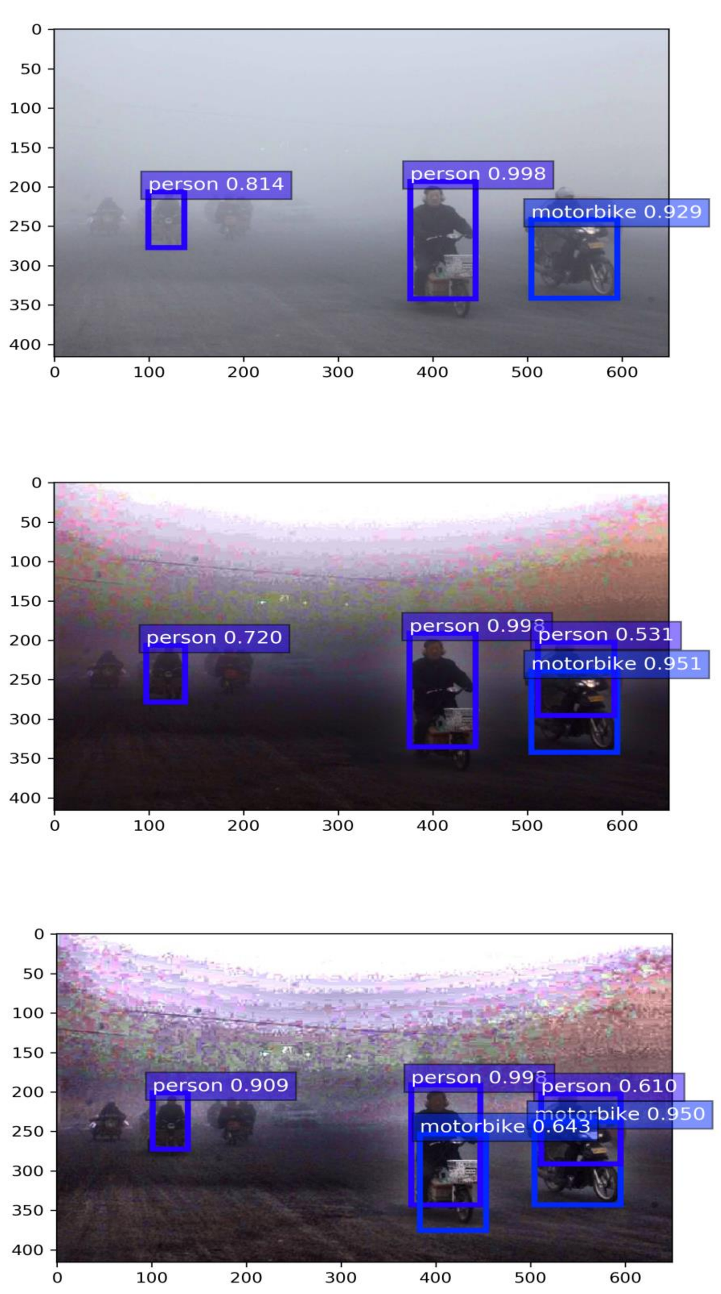

Figure2. 'fog3' image from 'e-today' journal. From top, original, DCP, and CLA + DCP image.

1. CLAHE + DCP showed the best performance on the object recognition task, especially on the YOLOv3(trained with Pascal VOC dataset with Darknet53), as Figure3 shows. We could infer two reasons for this superiority.

2. First, CLAHE made a bigger contrast between objects and backgrounds, and it helped DCP to attain the bigger t (transmission) values on objects, and the lower on backgrounds(or air-light).

3. (Hypothesis) The second one was 'halo artifact'. Halo means white distortion made near objects, which was reported as a weakness of DCP. (12, 12) size patch made the best performance, as shown in Figure 4.

-> CLAHE + DCP (with 12 patch size) image seems awkward, but it showed the best performance on the object recognizing task among the others.

	Number of Object Detected		
Method	**image1**	**image2**	**image**
Original	2	3	3
DCP	2	3	4
CLAHE	2	4	3
Auto-Retinex	2	3	5
CLA + DCP (Proposed)	2	4	5
Auto + DCP	2	3	4

Figure3. Results of each algorithms on Yolo v3

	Number of Object Detected		
Patch Size	**image1**	**image2**	**image3**
(3, 3) (By He[1])	2	3	4
(10, 10)	2	4	5
(12, 12) (Proposed)	2	4	6
(15, 15)	2	4	5
(20, 20)	2	4	5
(30, 30)	2	3	4

Figure 4. Results of changing patch size of CLA + DCP on Yolo v3

Figure5. Halo effect made by bigger patch size. Patch size 3(right), and 15(left)

결론 및 제언

- Seeing is NOT believing, at least for computers.
- Need validation with a real-driving dataset. (In progress)
- Need more research based on more algorithms e.g. Color Attenuator Prior or DehazeNet.

참고문헌

1. K. He, K. Sun, and X. Tang, "Single image haze removal using dark channel prior," in IEEE Conference on Computer Vision and Pattern Recognition, 2009.
2. J, Redmon, and A, Farhadi, "YOLOv3 : An Incremental Improvement", arXiv preprint, 2018.
3. B. Li, W. Ren, D. Fu, D. Tao, D. Feng, W. Zeng, and Z. Wang, "Benchmarking Single Image Dehazing and Beyond," in IEEE Transactions on Image Processing, 2019.