Review on State of Art Image Enhancement and Restoration Methods for a Vision Based Driver Assistance System with De-weathering

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Abstract - **The mission of intelligent vehicles is to assist the driver in decision making. The researchers have paid attention on developing various driver assistance systems in order to assure road safety. Most of the driver assistance systems do not produce accurate results in poor weather conditions. Poor visibility is considered to be a main reason for accidents. When the weather is poor (haze, fog, darkness, snow etc...) the driver cannot get a clear view of the road. Images of outdoor scenes captured in bad weather are severely degraded. Most of the outdoor vision applications require robust detection of image features.**

The main aim of the paper is to review state-of-art image enhancement and restoration methods for a Vision based Driver Assistance System which will help the driver by providing a clear view of the road when the weather is bad. This process is called "De-weathering". Reasons for degradation are explained in order to provide the scientific background of the problem. Various image enhancement methods are reviewed in this paper such as interactive de-weathering, de-weathering using multiple images, model based methods, non-model based methods and image de-noising, in order to find a suitable approach for the vision based driver assistance system.

Keywords- Image de-weathering; vision enhancement; Computer vision; Image de-noising;

I. INTRODUCTION

Technology is rapidly increasing the capabilities of modern vehicles as the field of transportation systems covers a broad variety of technologies such as pedestrian tracking, road lane detection, automatic break system, etc…

But in various weather conditions the quality of the images grabbed by in-vehicle cameras (visible light range) is degraded [1]. Due to the above reason the accuracy of driver assistance systems depends on cameras which are sensitive to weather conditions.

Apostoloff, [2] believes that the human driver is the most unreliable component of the driving process. If responsibility is taken away from the human driver, the safety of the overall system will be increased. Poor visibility on the roads is regarded as the main cause for many accidents in the world. Images of scenes captured in bad weather (rain, fog, haze) degrade significantly because of the severe reduction in contrast and colour. Most outdoor vision applications suffer from that issue. [3].

The main purpose of this paper is to present a brief overview of these areas, in order to facilitate a better understanding of the state-of-the-art in vision enhancement techniques for driver assistance systems. The advantages and disadvantages of previous work will be discussed in order to find a suitable approach for a vision based driver assistance system.

II. REASONS FOR DEGRADATION OF THE IMAGE

The reason for bad vision is the presence of the considerable number of atmospheric particles with significant size and distributions in the participating media.

Condition	Particle type	Radius (μm)	Concentration (cm^{-3})
Air	Molecule	10^{-4}	10^{19}
Haze	Aerosol	10^{-2}–1	10^3–10
Fog	Water droplet	1–10	100–10
Cloud	Water droplet	1–10	300–10
Rain	Water drop	10^2–10^4	10^{-2}–10^{-5}

Figure 1: Weather conditions and associated particle types, sizes and concentrations [4]

The degradation level is increased with the distance from camera to the object due to the following reasons specified by Zimmerman et al., [5]

1) Light reflected from the object surface is attenuated due to the scattering by particles such as Molecule, aerosol, water droplet and water drop
2) Some direct light flux is scattered toward the camera/eye. Scattering of the light is caused by refraction. When light passes from one medium to another, the speed is changed and it is the main reason for deflection. The whole process is called