Advanced Methods in Luminance Processing

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The article deals with the night traffic area from the perspective of the vehicle driver. It examines the traffic space primarily based on luminance, which is crucial for the human eye in recognizing individual objects. The research aims to create a 3D model of the nighttime traffic space based on the luminance values at each point. To achieve this, a method was chosen to integrate data from a luminance analyzer into the point cloud captured by a 3D scanner. This method was chosen in order to create an accurate model capturing the real environment. The resulting model is intended to contribute to understanding the perception of the nighttime space by vehicle drivers.

The research method is based on the integration of currently widely used technologies namely luminance analysis and 3D scanning. From a safety assessment perspective, luminance analysis is essential for evaluating nighttime level of traffic safety, both as a preventive tool for identifying potential risk areas on the road network and for retroactively understanding the causes of traffic accidents under degraded visibility conditions. Conversely, 3D scanning serves primarily as a basis for developing road network models or as a tool for reverse engineering.

Luminance measurement was conducted by using a luminance analyzer, where the same location was measured from multiple directions (angles). Subsequently, 3D scanning of the same location was performed from the same positions. Luminance measurement was based on European standards CEN TR/EN 13201 'Road Lighting', which includes a section on lighting measurement methods, including luminance analysis. The result of luminance measurement was a photo converted into a luminance channel, where each pixel contained information about the luminance of the respective point. Subsequently, a colour was assigned to each point based on the luminance level, according to a defined scale. The resulting colour spectrum of luminance, or individual luminance colour values, was then implemented into the point cloud obtained by the 3D scanner. The colour spectrum of the point cloud was transformed according to the measured luminance intensity using the luminance analyzer. This process resulted in a final point cloud containing specific luminance values and its form represents the 3D model transformed into the luminance channel.

The outcome of the work is a model based on data directly measured from the field for a specific location, at a specific time. Such a model has several advantages and disadvantages. The main advantage of the model should be its accuracy, stemming from quality static luminance measurements using defined procedures. This method increases accuracy compared to dynamic luminance measurements through vehicle passage equipped with measuring devices.

The disadvantage of the model can be perceived mainly in its time-consuming nature to obtain adequate outputs.

The main significance of the conducted research, including the created 3D model can be seen in the extension of the current knowledge of luminance distribution in real environments and its transformation from 2D to 3D space. Another benefit can be seen in understanding the folding of luminance of the same object from multiple directions/angles. Based on this knowledge, conditions and necessary steps can be defined that will lead to the possibility to analyse larger spatial areas. In the case of a large comprehensive model, opportunities for a range of further research open up. For example, the creation of a simulation environment where it is possible to study drivers' reaction times or obstacle visibility.