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A Multi-Stage Learning Framework for Reliable and Cost-Effective Estimation of Vehicle Yaw Angle

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Abstract : Yaw angle plays a significant role in many vehicle safety applications, such as collision avoidance and lane-keeping system. Although the estimation of the yaw angle has been extensively studied in existing literature, it is still the main challenge to simultaneously achieve a reliable and cost-effective solution in complex urban environments. This paper proposes a multi-stage learning framework to estimate the yaw angle with a monocular camera, which can deal with the challenge in a more reliable manner. In the first stage, an efficient road detection network is designed to extract the road region, providing a highly reliable reference for the estimation. In the second stage, a variational auto-encoder (VAE) is proposed to learn the distribution patterns of road regions, which is particularly suitable for modeling the changing patterns of yaw angle under different driving maneuvers, and it can inherently enhance the generalization ability. In the last stage, a gated recurrent unit (GRU) network is used to capture the temporal correlations of the learned patterns, which is capable to further improve the estimation accuracy due to the fact that the changes of deflection angle are relatively easier to recognize among continuous frames. Afterward, the yaw angle can be obtained by combining the estimated deflection angle and the road direction stored in a roadway map. Through effective multi-stage learning, the proposed framework presents high reliability while it maintains better accuracy. Road-test experiments with different driving maneuvers were performed in complex urban environments, and the results validate the effectiveness of the proposed framework.

Keywords : gated recurrent unit, multi-stage learning, reliable estimation, variational auto-encoder, yaw angle
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