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**Title: A Vehicle Lane-Changing Model in Tunnel Area Based on V2X Environment**

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Introduction:

The tunnel area is a critical part of the road network, and it is essential to ensure the safety of drivers when they change lanes in this area. The vehicle-to-everything (V2X) environment has been proposed as a promising solution for improving road safety. This research paper aims to propose a vehicle lane-changing model in the tunnel area based on the V2X environment. The study takes into account the effects of brightness and noise on a driver's lane-changing decision and response time.

Methodology:

The research methodology involved three main steps. First, the study analyzed a driver's lane-changing decision intention and the premise of a safe lane change. Second, the extent to which brightness and noise affect a driver's lane change was quantified through the driver's lane-change-response time. Third, the study proposed a lane-changing model by considering tunnel brightness and noise on the V2X environment.

In step one, the study analyzed a driver's lane-changing decision intention by using fuzzy logic theory. Fuzzy logic theory is used to deal with uncertain or vague information by assigning degrees of membership to different categories. In this case, fuzzy logic theory was used to determine whether or not a driver intends to change lanes based on factors such as speed difference between vehicles, distance between vehicles, and relative position of vehicles.

In step two, the study quantified how brightness and noise affect a driver's lane-change-response time by conducting experiments with human-driven vehicles, hybrid driving vehicles, and autonomous vehicles. The experiments were conducted in different tunnel environments with varying levels of brightness and noise. The response time was measured as the time it took for drivers to initiate a lane change after receiving an alert signal.

In step three, the study proposed a vehicle lane-changing model by considering tunnel brightness and noise on the V2X environment. The model is primarily composed of three modules: decision model for vehicle lane changing, safety-evaluation model based on safety distance, and vehicle lane-changing model considering noise and brightness effects.

The decision model for vehicle lane changing is based on fuzzy logic theory. The input variables include speed difference between vehicles, distance between vehicles, relative position of vehicles, and tunnel brightness. The output variable is the degree of membership that represents the driver's intention to change lanes.

The safety-evaluation model is based on the safety distance between vehicles. The model calculates the minimum safe distance required for a vehicle to change lanes without causing a collision with other vehicles. The safety distance is calculated based on the speed of the vehicle, the speed of other vehicles, and the relative position of other vehicles.

The vehicle lane-changing model considers noise and brightness effects. The model takes into account the driver's lane-change-response time, which is affected by tunnel brightness and noise. The model also considers the safety distance calculated by the safety-evaluation model to ensure that lane changes are made safely.

The mathematical equations used in this study include fuzzy logic theory equations for determining a driver's lane-changing decision intention, safety distance equations for calculating minimum safe distances between vehicles, and response time equations for measuring how brightness and noise affect a driver's lane-change-response time.

Conclusion:

In conclusion, this study proposed a vehicle lane-changing model in tunnel areas based on the V2X environment. The study analyzed a driver's lane-changing decision intention and response time under different levels of brightness and noise. The proposed model takes into account tunnel brightness and noise effects on a driver's decision-making process and response time. The study provides valuable insights into improving road safety in tunnel areas using V2X technology.