Microsimulation-based Analysis of the Effect of Hard Shoulder Opening on Motorway Traffic

Master‘s Thesis of Muhammad Farooq

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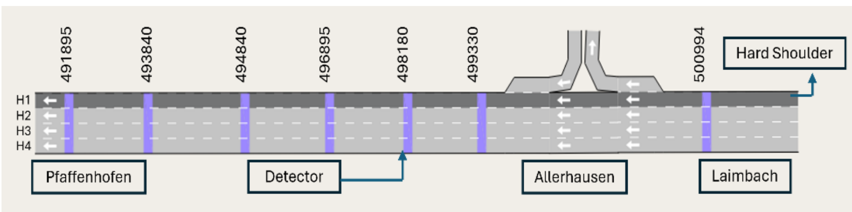

Figure 1: Motorway Layout from Laimbach to Pfaffenhofen

Introduction and Objective

Hard shoulder running is an ATM strategy to open the hard shoulder lane temporarily for general traffic during peak hours to reduce traffic congestion, delay, and pollution. HSR was introduced in 1996 in Germany.

This study aims to develop a section of the A9 motorway from Laimbach to Pfaffenhofen, perform calibration by modifying traffic parameters, validate the model, and design a new advanced control strategy to control the hard shoulder lane.

Methodology

The model is developed using AIMSUN microsimulation software. The traffic flow is introduced as traffic states after cleaning the model and setting up road and vehicle types. Car is used as the vehicle type, and the hard shoulder lane is created as a reserved lane, which can only be used under specified conditions. Model is calibrated by modifying traffic parameters and then validated using GEH statistics and RSMPE methods.

A new advanced control strategy to control the hard shoulder lane is proposed. The new strategy controls the hard shoulder lane using the defined opening and closing thresholds and implements VSL during the HSR operation to maintain speed harmonization and minimize lane changes. The new strategy considers the 15-minute moving average of the left lane flow to control the hard shoulder lane. The new strategy uses different thresholds and continues each phase for at least 12 minutes to avoid frequent opening and closing of the hard shoulder lane.

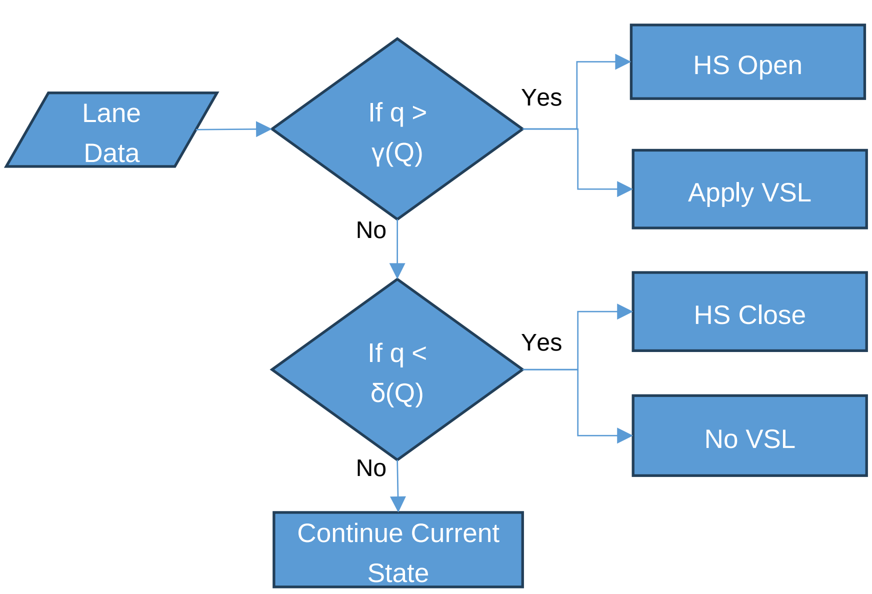

Figure 2: Proposed Advanced Control Strategy for HSR

Results

The current and proposed HSR control strategies are compared based on flow, speed, travel time, and TTS analysis. With the new advanced strategy, the speed is reduced due to VSL, increasing road capacity.

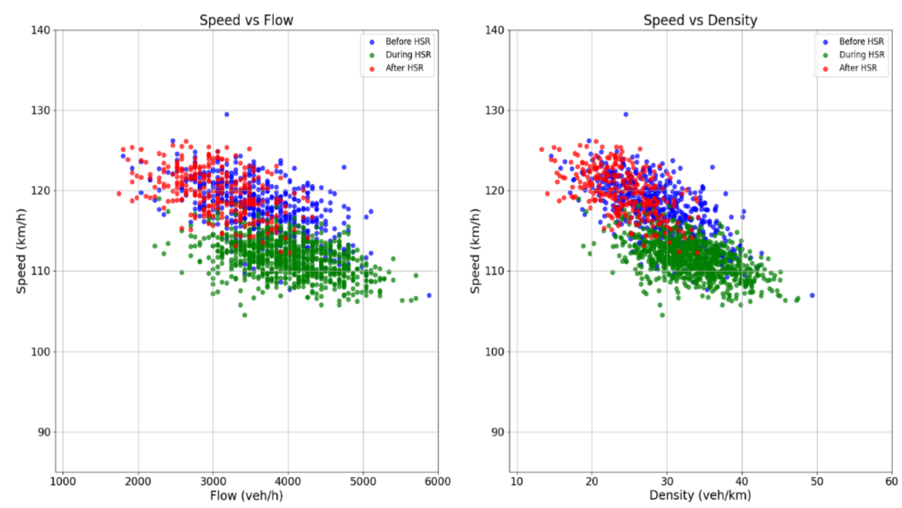

Figure 3: Fundamental Relations of Speed, Flow, and Density

The proposed strategy reduces the HSR operation time by 14 minutes without significantly impacting the TTS. Moreover, the new strategy also maintains speed harmonization due to VSL. The TTS reaches around 5.8 hours during the HSR operation

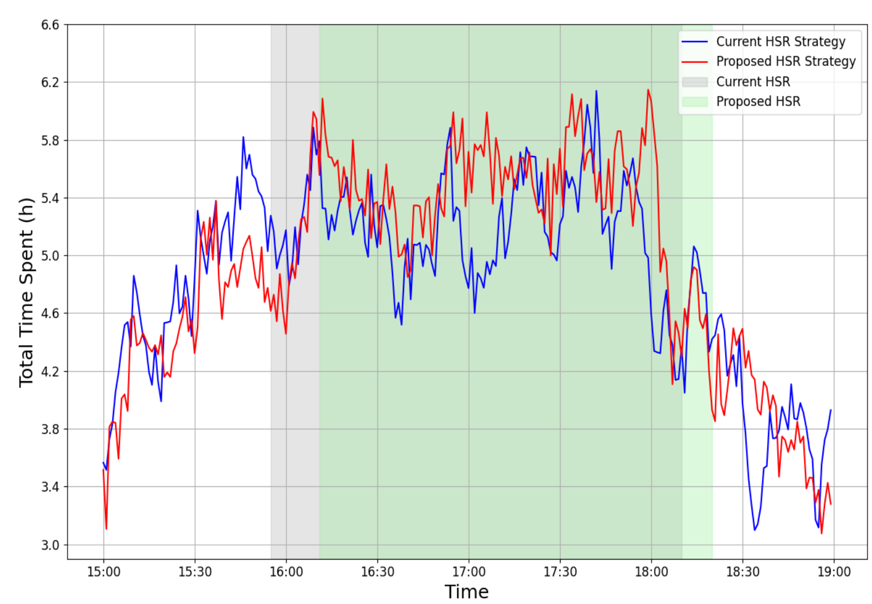

Figure 4: TTS with Current and Proposed Advanced Control Strategy

Conclusion

The HSR operation increased the overall network capacity. The proposed HSR control strategy reduced the HSR duration by nearly 10 % with just a 1 % increase in the TTS. Speed harmonization is maintained during the hard shoulder operation. The new strategy also avoids frequent activation and deactivation of hard shoulder lanes to minimize driver confusion. The research can be further expanded by developing a long-term prediction model that incorporates urbanization and population growth rates.