

From HD Maps to Digital Twins: Survey, Challenges and Future Perspectives

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In connected and cooperative automated mobility (CCAM), the more automated vehicles are able to perceive, model and analyze the surrounding environment, the more they become aware, capable of reasoning, decision making as well as safely and efficiently executing complex driving scenarios. High-definition (HD) maps represent the road environment in unprecedented centimetric-level precision with lane-level topological, geometric and semantic information, making them a core component in smart mobility systems and a key enabler CCAM technology. These maps provide automated vehicles with a strong prior to understand the surrounding environment. An HD map is also considered as a hidden or virtual sensor, since it aggregates knowledge (mapping) from physical sensors, i.e. lidar, camera and radar, to build a model of the road environment. This technology is evolving very quickly towards digital twins as a holistic representation of the digital infrastructure of smart cities to include not only road geometry and semantic information but also live perception of road participants, weather conditions, work zones and accidents. Building and maintaining such a representation could be possible via crowd-sourcing of vehicles and road-side perception sensors, however, developing an efficient and reliable framework to handle this process raises many research and technical challenges. This article provides an extensive literature review of the state-of-the-art of mapping for automated vehicles. We provide synthesis and in-depth insight of the recent research efforts in this field. Furthermore, we identify the current challenges and propose future research perspectives for the next generation HD maps, i.e. Digital Twins.