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Automatic Scenario Generation based on Laserscanner Reference Data and Advanced Offline Processing

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***Abstract*—This paper presents the use of advanced perception systems for the automated generation of simulated driving scenarios. We describe our advances in the fields of laser scanning processing for reference generation, and illustrate the use of reference data for constructing simulated virtual scenarios that can be loaded, manipulated and used within a commercial simulator.**

I. Introduction

The increasing level of automation on vehicles and the intense development of ADAS have led to systems that must deal with extremely complex traffic scenarios. ITS currently use various sensor technologies and combine advanced algorithms for sensor fusion, object tracking, classification, risk estimation and vehicle control. As a result, it is rapidly becoming infeasible to check the performance of each new (sensor) system in the traditional way by driving around, storing data, manually labeling the data for reference, and manually evaluating the results.

One of the approaches to address these difficulties is to install an additional Reference Sensor System (RSS) on the vehicle which is already equipped with the prototype (sensor) system that is going to be tested (DUT – device under test). The recorded data from the RSS is processed to automatically create reference scenarios, including automatic labeling of objects and events. Based on this reference data, the DUT can be automatically and objectively verified. The reference data from the RSS can also be converted into a set of simulated scenarios which can be used within a CAE environment. These simulated "ground-truth reference scenarios" that can be loaded and manipulated provide engineers with a useful platform for checking the performance or consequences of design changes or new concepts.

This paper presents how advanced perception systems can be used to obtain reference data for the automated generation of simulated driving scenarios. Section II describes our advances in the fields of laser scanning processing for reference generation. Section III presents our efforts towards constructing simulated virtual scenarios from this reference data. Conclusions and future work are finally discussed in Sec. IV.

II. Reference Sensor Systems (RSS) through Advanced Scan Processing

Several advancements in the field of laser scanning allow Ibeo sensor technology [1] to be used as RSS for automatically generating reference scenarios from laser scan data. Current generation laser scanners [2] can detect objects with a very high precision relative to the scanner. If a digital map is available which contains landmarks with centimeter accuracy, then the absolute position of the laser scanner can be determined to within a few centimeters (see Figure 1), thus improving the accuracy of all tracked objects. The scanner is effectively used as a differential sensor, analogous to Differential GPS (DGPS), but without the need

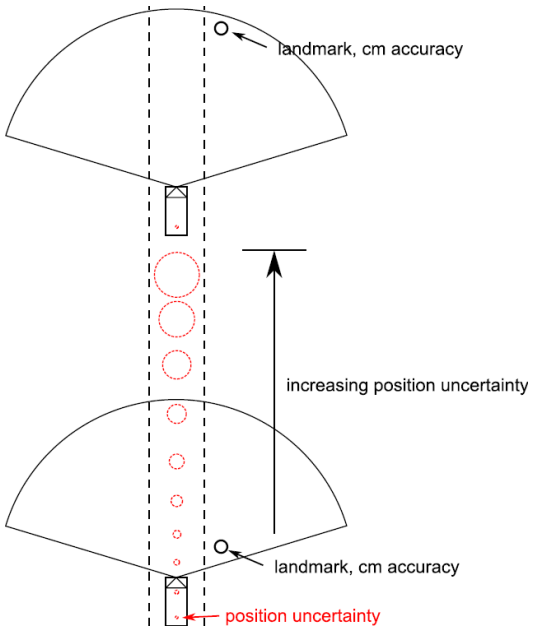

Figure 1. Differential Scanning

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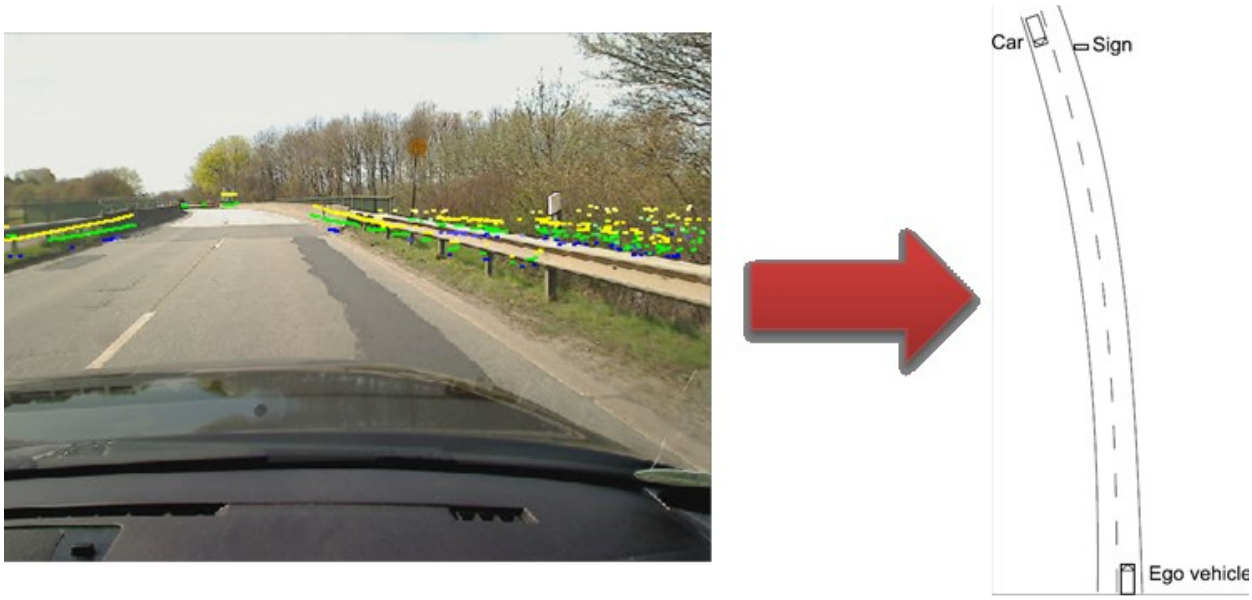

Figure 2. Example scenario (left) and the resulting reference scenario (right)

for a base station or for a clear view of the sky.

A further improvement is the use of offline processing to fully analyze the scenario. State of the art online tracking algorithms are inherently limited by real-time requirements. If the data is reprocessed offline, it becomes possible to look ahead for all observations of an object and associate them with the first instant that the object is visible, which allows the system to be used as a true reference, since no online sensor can look into the future. This also allows the use of a "best-situation-classifier". The point in time where an object is most clearly visible can be used to classify the object, and this classification can be extended to the lifetime of the object. Additional benefits are improved robustness to occlusions, reduced uncertainty of the ego vehicle position between landmarks, and increased accuracy of object trajectories.

As an example, consider the scenario in Figure 2 (left). A sign and an oncoming vehicle are just visible by the laser scanner. Figure 3 shows the results of two tracking approaches. In the online approach (left), the approaching vehicle is initially detected, but it is not yet classified and the outline is not clear. As the vehicle gets closer, the outline can be clearly seen and it is classified as a car. In the offline approach (right), this information is associated with the object in the first instant that it is visible, allowing a more accurate reconstruction of the scenario (Figure 2, right).

III. Virtual Scenarios From RSS

ADAS applications and automotive sensors are normally first tested using simulators. Moreover, real testing scenarios and conditions must be manually converted into virtual scenarios for further testing. It is thus extremely valuable to be able to automatically obtain virtual scenarios from real world scenarios. The data provided by the RSS presented Section II can be indeed transferred into a simulation tool, as described below.

We use in this work the PreScan simulation environment from TASS [4]. PreScan is simulation tool popular for the development and validation of ADAS and active safety systems. Figure 4 shows a typical example virtual scenario that could be generated using RSS and loaded into PreScan. All objects obtained through the RSS can be converted to PreScan standards, which allows us to easily manipulate, edit and experiment within the virtual simulator.

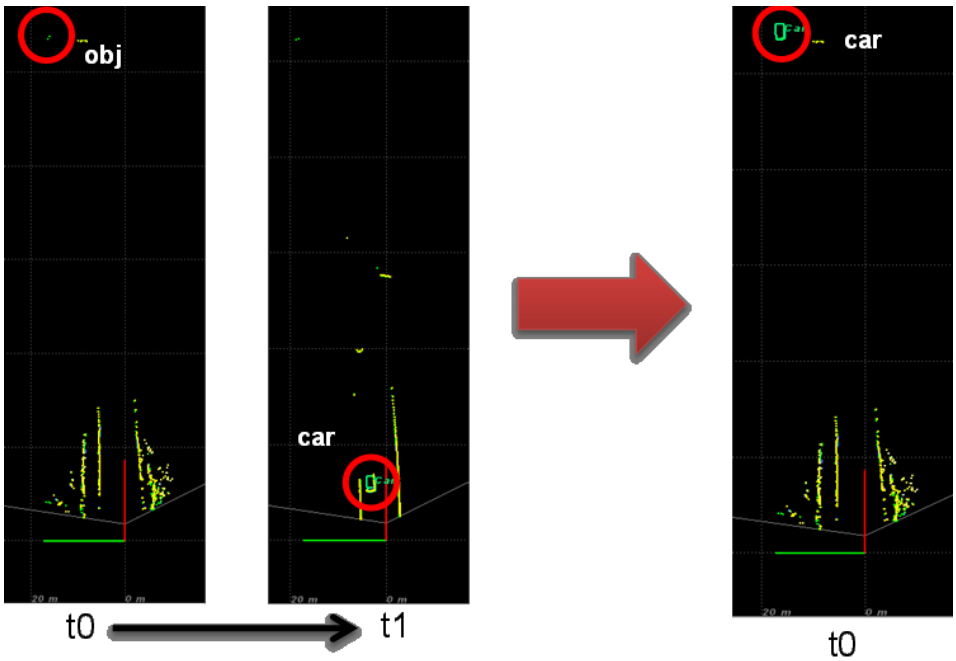

Figure 3. Online (left) and offline (right) tracking algorithm result

Figure 4. Typical virtual scenario with people and background buildings that can be represented by PreScan

IV. Conclusion

This paper presented the use of advanced perception systems for obtaining reference data for the automated generation of simulated driving scenarios. We described our advances in the fields of laser scanning processing for reference generation, and illustrated the use of reference data for constructing simulated virtual scenarios that can be loaded, manipulated and used within a commercial simulator.

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