ODAS Obstacle Detection Assistance System

Landri FEL 1,

1 BOMBARDIER Transportation Austria . Vienna . Austria

Abstract

BOMBARDIER Transportation together with its research partner AIT has developed an optical 3D sensor system for LRVs. The system is designed to the specific requirements of rail vehicles with regard to reducing the risk of collisions and aiming to make LRVs thereby even safer. The BOMBARDIER Driver assistance system (ODAS) enables LRVs to detect different obstacles such as other trams and vehicles as well as persons, and it automatically evaluates the potential collision risk and responds accordingly.

The basic concept of the ODAS is that the vision based technology monitors the area in front of the vehicle in real-time. It detects the rail tracks and generates a 3D scatter plot whereby the system identifies hazardous objects on the vehicle’s path. Subsequently it identifies potential collisions by classifying hazardous obstacles within the swept path. The system warns the driver and depending on the operator’s requirements, it possibly activates additional vehicle safety features. The development of the system involved numerous extensive research and development activities. The fundamental development phase with focus on the specific characteristics of LRVs, has culminated with the 1st worldwide authorization for use in commercial service for the Frankfurt operator VGF in June 2015. The ODAS system is currently being evaluated in service on different tramways by four operators in Germany & France and is easy to retrofit on existing LRVs. This technology is permanently developed for introducing new safety features and opens a wide field of new development possibilities for LRVs and other type of rail vehicles.

1. Introduction

Nowadays Light Rail Vehicles (LRV) are safe, comfortable and environmentally friendly means of public transport. They often operate in streets with shared traffic involving pedestrian and cars. Consequently, like other road users, they are involved into collisions causing injuries, fatalities and very costly material damage. Driver Assistance Systems (DAS) are making a breakthrough in accident prevention in the automotive industry. For these reasons it is an obvious step to introduce similar technology into LRVs.

Rail technology leader BOMBARDIER Transportation together with its research partner AIT (Austrian Institute of Technology) & industrial partner ME (Mission Embedded) has developed an optical 3D sensor system for LRVs acting as Collision Avoidance System (CAS). The system is designed to the specific requirements of rail vehicles with regard to reducing the risk of collisions and aiming to make LRVs thereby even safer. The BOMBARDIER driver assistance system for avoiding collision is called ODAS for Obstacle Detection Assistance System. It enables LRVs to detect different obstacles such as other trams and vehicles as well as persons, and it automatically evaluates the potential collision risk and responds accordingly.
2. Description

Concept

ODAS is an Obstacle Detection Assistance System based on stereo-cameras. It is assisting the driver by sending alarm or by braking in case of collision risk.

The basic concept of the ODAS is that the vision based technology monitors the area in front of the vehicle in real-time. It detects the rail tracks and generates a highly detailed 3D scatter plot whereby the system identifies hazardous objects on the vehicle’s path. Subsequently it identifies potential collisions by classifying hazardous obstacles within the swept path. The system warns the driver and depending on the operator’s requirements, it possibly activates additional vehicle safety features.

The ODAS system has similar performance and limitation in terms of visibility as the driver’s eyes. It works properly during day, night, under rain and snow, provided that the luminosity and visibility conditions are acceptable.
The concept of the ODAS system is not a simple derivative of technologies and solutions widely used in the automotive industry.

Because LRV operations have fundamental differences with car operation, ODAS has been specifically developed for offering functions and a level of performance that match with the requirements of the tramway drivers and the tramway operators.

Due to the fix course of rail vehicle (wheels stay on tracks) and they comparatively long braking distances, many features cannot be extrapolated from automotive applications. This is the case, for example for the required range of detection and for the time to collision computations.

BOMBARDIER is developing ODAS as a standard & evolutionary platform solution that:

- will progressively offer more complex, safety relevant functions like automatic emergency braking
- can be easily customized to suit to specific operational requirements from each LRV operator.
Main components

The ODAS system consists mainly in 5 components: a group of 3 cameras, a Synchronization Box and an ODAS controller.

The group of 3 camera is mounted most often behind the driver cabin windshield, in its upper part. One camera makes the track detection, one first pair of camera generates the 3D long range field and a second pair of camera generates the 3D short range field.

The Synchronization Box supplies electrically the camera and ensures the chronological superposition of the 3 pictures in each video frame.

Thanks to an innovative software, using the camera picture information, the ODAS Controller integrates mainly 6 different functions:

- Identification of the track position
- Computation of the future dynamic envelop of the tramway
- Identification of obstacles & computation of their future trajectory
- Computation of “Time To Collision” & definition of collision risk levels
- Management of all input / output signals
- Monitoring and reporting of ODAS system health status

The picture below illustrate some of the core functions of the ODAS controller by superimposing important computed parameters on a camera pictures.
To cope with the specific design and geometry of different driver cabins, several solutions for installing the camera have been developed and successfully implemented.

**Pilot Project Frankfurt**
Camera glued behind the windscreen

**Pre-serie Frankfurt**
Modular housing behind the windscreen

**Evaluation Marseille**
Roof mounted camera

**Development status**

The development of the system has involved numerous extensive research and development activities such as implementing an optimal 3D scatter plot, developing appropriate software solutions for rail track detection, evaluating and selecting the suitable hardware (e.g. suitable light-sensor) and developing a reliable obstacle detection and classification.

The graph below provides a short overview of the planning for the ODAS development.
After the fundamental development phase with focus on the specific characteristics of LRVs, a BOMBARDIER FLEXITY tram with an ODAS prototype onboard was temporarily tested during normal passenger service on the network of the Frankfurt Transport Company (VGF) in 2014.

After the successful evaluation of the system’s performance, VGF has decided to equip 74 bi-directional vehicles with the innovative ODAS system. The fine tuning of the software has been carried out along 2015, culminating with the 1st worldwide authorization for operation of a collision avoidance assistance system on a tramway in June 2015 for VGF in Frankfurt.

The initial prototype components have been improved or replaced to meet the industry standard and a second partner Mission Embedded (group FREQUENTIS) is in charge of the industrialization process, the hardware and the service software delivery.

Beginning 2016, a total of 5 vehicles are in commercial service by VGF in Frankfurt, accumulating experience for further reducing the false detection rate. The continuous on-going functional refinement will be progressively implemented in the rest of the VGF fleet.

In 2016, the ODAS system, which is very easy to be retrofitted on existing vehicles, is evaluated in parallel by 3 other operators:

- RTM (Régie des Transports de Marseille) in Marseille on one tramway Type Flexity Outlook
- BVG (Berliner Verkehrsbetriebe) in Berlin on 2 tramways types GT6 & Flexity
- KVB (Kölner Verkehrs-Betriebe AG) in Köln on 2 city trains type K4500
Perspective

The ODAS system is still under development for being able to offer further functionalities (from ODAS step 2 to Step 3)

Prospectively this technology is not just a safety feature, but it opens a wide field of new development possibilities for LRVs, like adaptive lighting systems with cornering headlights for curves, service optimization with curve dependent lubrication or even simplified maintenance of infrastructure (e.g. monitoring of vegetation’s growth). Its application to other railway vehicle types is under consideration too.

3. Conclusion

This brand new technology is an important milestones in regard to LRV safety and benefits both operators and other road users.

ODAS offers unique features and performances that currently effectively address some of the needs of LRV’s operators for new and existing vehicles.

ODAS is still undergoing a permanent development process for enabling new functions and application.