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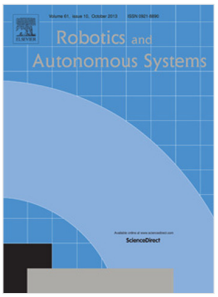

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Unsupervised obstacle detection in driving environments using deep-learning-based stereovision

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Abstract

A vision-based obstacle detection system is a key enabler for the development of autonomous robots and vehicles and intelligent transportation systems. This paper addresses the problem of urban scene monitoring and tracking of obstacles based on unsupervised, deep-learning approaches. Here, we design an innovative hybrid encoder that integrates deep Boltzmann machines (DBM) and auto-encoders (AE). This hybrid auto-encode (HAE) model combines the greedy learning features of DBM with the dimensionality reduction capacity of AE to accurately and reliably detect the presence of obstacles. We combine the proposed hybrid model with the one-class support vector machines (OCSVM) to visually monitor an urban scene. We also propose an efficient approach to estimating obstacles location and track their positions via scene densities. Specifically, we address obstacle detection as an anomaly detection problem. If an obstacle is detected by the OCSVM algorithm, then localization and tracking algorithm is executed. We validated the effectiveness of our approach by using experimental data from two publicly available dataset, the Malaga stereovision urban dataset (MSVUD) and the Daimler urban segmentation dataset (DUSD). Results show the capacity of the proposed approach to reliably detect obstacles.

Keywords: Deep learning, DBM, Autoencoder, OCSVM, Monitoring, Stereovision

1. Introduction

1.1. Background

Over the past two decades, intelligent transport systems, driver assistance systems and autonomous vehicles have received increasing research attention (Labayrade et al., 2002; Fakhfakh et al., 2013; Sun et al., 2013; Appiah and Bandaru, 2015; Nalpantidis et al., 2016; Zhang et al., 2017). Localization and obstacle detection systems are key enablers in the developmentof practical autonomous robots and vehicles and for intelligent transportation systems so that accidents can be avoid. Indeed, the main objective of a detection and localization of obstacles system is to improve safety and comfort, while reducing the risk of collisions by alerting the driver or providing useful information for rapid decision making. Moreover,