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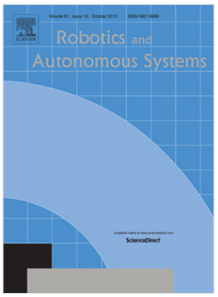

Layout optimization of a system for successive laser scanner detection and control of mobile robots

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Abstract

This paper describes a new, innovative method by which multiple mobile robots can be detected by a laser scanner. Each robot incorporates bars in its construction which generate a significant pattern in the laser scan. The proposed technique allows a robust detection and control of successively moving robots, despite the partial shadowing through the bars.

In this paper the optimal number of bars and their best arrangement for detection is shown. Furthermore the impact of different bar diameters is described. Increased visibility of the bars by the use of multiple laser scanners and their positioning to ensure detection of the robots is also described. Finally it describes the accuracy that can be achieved with this system. The position accuracy was determined by trials on an actual system.

Simulations and experiments confirm that this is a reliable and precise method for position determination of multiple robots using a single sensor.

Keywords:
mobile robots, multi-robot system, robot tracking system, intelligent space, multi-robot localization

Multimedia material

https://www.audi-mediacenter.com/de/audimediatv/video/audi-smart-factory-p-tech-day-footage-2108 (1:13 - 2:47)

1. Introduction

Intelligent spaces are areas that are equipped with sensors which enable the spaces to perceive and understand what is happening in them [1]. There are several approaches in the topic "mobile robotics" to use them in these intelligent spaces. The robots don't navigate with sensors mounted on them, but rather are controlled externally through a sensor network established in this intelligent space. In this manner the mobile robots can navigate without the need for a map, compass, or GPS module [2]. Sensors and computing power on the robots themselves can be reduced or completely dispensed. This will reduce the extra cost for the internal equipment needed to recognize the location, and it will also simplify the robot development [3].

Recently, this technology is being introduced into the manufacturing environment, which ushers in a fourth industrial revolution with the aim of realizing a smart factory [4]. Therefore, this technique will take on greater significance in the industrial environment in the future.

This paper deals with the required detection methods for the mobile robots. Because high accuracy for positioning can be achieved in particular by optical sensors with direct visual contact [5], only optical techniques are considered. All these techniques require a direct line-of-sight. So usually it is not possible to detect successively arranged objects from the viewpoint of the sensor. However this paper describes a new and innovative method which enables exactly that. This method can be used for the detection, tracking and control of sensorless mobile robots.

2. State of the art

Frequently, cameras are used for this purpose in a top view. Therefore, they can be mounted on the ceiling [6] [7] [8] [9] or on an unmanned aerial vehicle (UAV) [10] [11] [12]. Attaching an omnidirectional camera to a mobile robot can also enable a view from above [13] [14]. A view from above presupposes that the top view of the robots always look the same. To support this, colored targets or barcodes are typically needed to facilitate detection. In this case placing various goods on the robots is difficult. Even the installation of cameras on mobile robots in a horizontal view is possible [15] [16] [17]. This assumes that the side view remains identical. Marks that simplify

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