Chapter 19
Design, Construction, and Programming of a Mobile Robot Controlled by Artificial Vision

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ABSTRACT

The design, construction and programming of a mobile robot controlled by means of artificial vision, capable of recognizing, grabbing and moving specific objects in a completely autonomous way is presented, together with the conceptual and theoretical-practical grounds for the work. A mechanically robust robot is built and a system is designed, allowing the mobility of two sensors jointly, i.e., artificial vision camera and distance sensor. This makes it possible to improve the range of artificial vision, over approximately 180°, achieving precise positioning of the mobile robot. The artificial vision camera, CMUCam 2, provides the mobile robot with great autonomy thanks to its excellent interaction with its surrounding world. Having a mobile robot like this will allow interesting developments to be made in various areas of mobile robotics.

INTRODUCTION

In recent years, there has been increasing interest in research on mobile robots due to the endless number of remote applications that can be developed with them, particularly in areas of high risk to human beings. Currently, thanks to the degree of development that has been reached in the field of mechanisms and sensors, the implementation of systems with a high degree of interaction with the environment has been achieved. This has allowed robots to get a more accurate description of their environment, such as sampling, analysis of the surrounding, detection of gases, leakage, or even sending video signals so that the observer is not exposed. Since mobile robots can now carry out their tasks with greater accuracy, precision and autonomy, the developments of control methods, as well as the implementation of new prototypes, are of high importance in the field of robotics.

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Mobile robots exhibit the advantage of integrating the functionality of a device or system with the mobility of an autonomous vehicle, offering a number of advantages, but also a number of yet unsolved technological barriers such as:

- Increased duration of battery charge to achieve greater autonomy.
- Increased potentialities of the navigation systems to allow automatic mobility in the most efficient, flexible, fault-tolerant and safe possible manner.
- Improved efficiency of the control of fleets consisting of various mobile robots to solve problems such as optimized scaling, routing or traffic management, etc.

RELATED WORK

Location is one of the key technologies in autonomous mobile robot navigation, as it is the foundation of the route plan and obstacle avoidance of mobile robots. The work of Wang and Zhao (2010) is concerned with the problem of determining the position of mobile robots by vision. A type of infrared landmark was designed; a system software based on Visual C++6.0 and OpenCV was build; and a location system for vision-based mobile robot and artificial landmark was developed. The infrared landmark image was acquired by a vision sensor and its mass center in the image was recognized by image processing. By the triangulation method, the robot's position in the world coordinate system was obtained. Experimental results show that the method could be applied in the field of self-localization of mobile robots.

On the other hand, this study focuses not only on controlling a mobile robot through artificial vision, but also on controlling the vision of one camera by the joint work of algorithms and the robot's motion. Shaikh et al. (2011) introduces a vision tracking system for mobile robots using Unscented Kalman Filter (UKF). The proposed system accurately estimates the position and orientation of the mobile robot by integrating information received from encoders, inertial sensors, and active beacons. These position and orientation estimates are used to rotate the camera towards the target during robot motion. The UKF, employed as an efficient sensor fusion algorithm, is an advanced filtering technique that reduces the position and orientation errors of the sensors.

Recent research by Pilar et al. (2014) present and emulate a wheeled robot for object transportation in a distribution center. The robot follows a free trajectory, which is controlled by artificial vision and fuzzy logic modules. The artificial vision system includes a webcam located in the upper part of the distribution center, which was used to calculate the location of the robot. Specifically, image segmentation technique of red color was implemented in the artificial vision system to determine the robot's position and orientation. The information obtained from the webcam is also employed by the fuzzy controller to estimate the robot's velocity, which is then send to the mobile robot wirelessly. The control of the motors and the wireless communication of the robot are performed by an Arduino platform, which supports an Xbee module for communications. The image processing and fuzzy control are implemented on a PC using Matlab. The light source selected generated a uniform diffuse lighting with not much glare in the environment, which enabled the artificial vision system to retrieve traits of interest from the physical surroundings.

The work of Figueiredo et al. (2016) presents the last developments in vision-based target tracking by an Autonomous Underwater Vehicle (AUV). The main concepts behind the visual relative localiza-