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Characterization of an Innovative Like-Eye Sensor for Feature Detection and Robot Sensing

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Abstract

In this paper the authors present an application of an innovative device consisting in a new optical sensor accurately moved by driving a controlled robotic arm. The new sensor is made up of nanocomposite material and it is composed of an optical fiber source, an optical fiber bundle receiver and a PDMS-Au tip able to enhance the light. The device allows to reconstruct the target characteristics taking advantage of the backscattered light. The motion of the sensor is obtained by means of a robot manipulator which gripper grasps and moves the sensor. The realized device has been tested in order to evaluate its ability to provide useful information on colours, surface opacity and profile of the detected objects.

Keywords: mechatronic device, damage detection, light coupling, nanocomposite materials, optical sensors, 3D object recognition, robotic implementation.

1. Introduction

In the last years, optical system have been becoming more and more strategic in many applications, in particular in endoscope systems by means of nanocomposite materials [1]. Basic endoscope system for optical images described in [2] concerns fundamental principle of a medical image detection. The proposed device enhances the light in order to detect information of analyzed tissues (by means of a data post-processing). Other systems, such as ultrasonic ones [3] or optical probe combined with a fluorescent agent [4] (detection of a volume by a fluorescent agent), can be used for detecting 3D image. The nanocomposite materials were discovered in [5] and then they were also used as optical amplifiers [6] and chemical sensors [7]. Such materials allow the enhancement of electrical and mechanical properties [8], the detection of cells [9] and the coupling of optical waveguides [10]. They find use for medical devices [11] and, moreover, they may be integrated in optical fibers for filtering applications [12] too. All the listed works do not include the possibility to integrate the nanocomposite materials in a tip for endoscopy. In the prototype proposed in this paper, a nanocomposite tip is dedicated to the detection of 3D objects and also for revealing properties of the tissues for medical and industrial applications [1]. The information about the detected object is encompassed in the optical reflectivity of the same object and, for its detection, it does not require fluorescent agents. Furthermore the optical signal is enhanced at the output of the source fibers and again enhanced at the input of the receiver fibers (double enhancement) with a large numerical aperture (large area of detection). In order to recognize 3D features of objects, the proposed sensor is mounted on the end-effector of a robotic arm, as illustrated in Fig. 2. The arm is controlled so that it can automatically move the optical sensor and start the measurement process only after achieving the desired end-effect or position and orientation. The possibility of using a robotic systemprovided with sensors in detecting different colors has remarkably interested the researchers in the last years (i.e. [13], [14]) as well as for reconstructing 3D objects (i.e. [15]-[18]) or for detecting analysis[19]. In this case the sensor output signals were