Cognitive Robot Referencing System for High Accuracy Manufacturing Task

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Abstract

Industrial robots can be considered very repeatable machines, but they usually lack of absolute accuracy. However, high accuracy during the execution of the task is becoming a more and more critical factor in industrial manufacturing domains. For that reason, in order to fully automatize manufacturing processes, high-precision tasks usually need the integration of additional sensors to improve robot accuracy. This paper proposes an embedded, cognitive and self-learning stereo-vision system that can be used to reference the robot position with respect to the work-piece, increasing robot accuracy locally. An industrial use-case is also proposed and experimental results are presented.

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Keywords: industrial robotics; stereo-vision; neural-network; robot referencing; high-accuracy manufacturing

1. Introduction

Nowadays, robots used for industrial applications still represent about 90 percent of the overall robotics market. The demand for more flexibility on the shop-floor requires novel robotic technologies, that are able to cope with a larger amount of variability than classical shop-floor robots. Classical industrial robots usually employed on the shop-floor are well-established components of modern manufacturing lines. They can be programmed to perform...
almost any movement, with very high repeatability [1]. However, industrial robots usually lack of absolute accuracy and adaptability. In manufacturing domains, the need of high accuracy during task execution is more and more becoming a critical factor. Depending on the application domain, the required accuracy can be obtained by exploiting different solutions. For example, in the automotive domain, welding tasks on small-medium work-pieces can be performed maintaining the object in a fixed position and making use of several well-defined reference positions to improve robot accuracy. On the other hand, in some manufacturing domains, this kind of approaches cannot be exploited: for example, in the aircraft assembly process, where large dimensions of the work-pieces (that cannot be fixed in a very precise way) accentuate the lacking of absolute accuracy for robots. In order to assemble together two pieces of an aircraft fuselage, a large quantity of holes needs to be drilled with high precision. Currently, this precision is obtained by mounting some special jigs directly on the fuselage, based on appropriate reference targets: pre-drilled holes are located on these jigs, in order to precisely guide the operator when manually drilling holes on the fuselage.

In order to perform the task in an automatic way with a robotized solution, the robot must be able to identify and localize with precision the referencing targets, and to move on the final positions composing the drilling pattern, guaranteeing a total absolute accuracy of less than 0.5 mm. (Fig. 1)

An additional difficulty to the automatization of the process comes from the variability of the referencing targets that can be used, without any specific a-priori knowledge for the robot. In fact, different targets with different shapes
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