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New Concept for Design and Control of 4 Axis Robot Using the Additive Manufacturing Technology

Mohamed Aburaia*, Erich Markl, Kemajl Stuja

Hoechstaedtplatz 6, Wien, 1200, Austria

Abstract

This work introduces a new concept for designing and manufacturing an industrial robot by using modern production techniques and a 3D modelling software. The most important requirements of this project were to build a customized, lightweight and low cost robot, capable to fulfil many industrial working tasks such as palletizing mobile telephone covers. For designing and optimizing the mechanical structure of the palletizing robot a SolidWorks- software was used. Integrating motion simulation tools in SolidWorks intensely reduces the engineering time for finding the optimal mechanical structure of the robot according to the industrial task. The robot parts are produced by using the additive manufacturing technology- powder material PA 2200. For solving the forward and inverse kinematics of the robot, the Software tool SimMechanics from MathWorks was used. This environment provided by the software enables building a human machine interface in order to store and program the robot targets. This project additionally shows the new benefited experience about mechanical structure of robots using the powder material PA 2200. Furthermore the advantages and disadvantages of this concept will be comprehensively explained.

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Keywords: Robotics; Additive Manufacturing; 3D Modelling; Simulation; Motion Control

1. Introduction

The aspiration of high degreed automation and the need of economically reproducible concepts, require the use of industrial robots. These robots experienced an enormous progress in the development recently; starting off with the

* Corresponding author. +43 1 333 40 77 – 502; fax: +43 1 333 40 77 – 99 502.
E-mail address: aburaia@technikum-wien.at

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first simply engineered robot and moving on to the intelligent robot performing a variety of kinematic designs.

In addition to the technological development which undertakes the domain robotics, new technologies such as additive manufacturing are gradually maturing leading to an enrichment of their field of application. This technology, which generate parts in a layered way, has a history of more than 25 years. These processes are not exclusively used for prototyping any longer. New opportunities and applications in appropriate manufacturing tasks opened up, even though the commercial impact is still modest [1]. By building three-dimensional parts in a layer-by-layer additive manner, the Rapid Techniques allow freeform fabrication of parts of complex geometry directly from their CAD models automatically, without having to use special fixtures as in the material removal processes. The rapid prototyping technology has helped product developers to develop their products more rapidly at lower costs in the ever changing and more competitive global market [2].

In order to fully exploit these advantages and to combine them with robotics, the idea was to build a 4 axis palletizing robot, which would be solid enough to fulfill industrial working tasks such as pick & place using the additive manufacturing technology. The first step in order to implement this concept, was to build a mini model with low cost components to test out this theory. Therefore an Arduino microcontroller, Servo motors (radio control servo motors) and a 6V vacuum suction as Endeffector were used.

2. Design and construction

Traditional engineering taught the manufacturability of the product while constructing models. This manufacturability differs according to the used production processes. Manufacturing costs and assembly are other factors that have to be taken into consideration. In addition to these factors, there are defined instructions for a product development process which has to be followed: starting off with devising the idea, up to mass production. Using the additive manufacturing process leads to a shortened lap time between the phases of the development process. Some phases may be even eliminated leading to a new redefinition of these factors. This changes caused a complete change of the product development process [3]. After drawing some sketches the next step was to start with the 3D design and modelling of links and joints of the robot (as shown in Figure 1). During the construction of the 4 axis palletizing robot, the focus was placed directly on the function, not on the way the axis would be manufactured. Furthermore, it has been taken into account to reduce the weight of the robot axis and to adjust the axis and joints on the built engines. Using modern CAD modelling and simulation software, it has made it possible to simulate the mechanical behavior of the used axis material during the motion study of the robot. The purpose was to achieve an optimum on the configured design through which we can obtain a maximum of motor torque utilization.

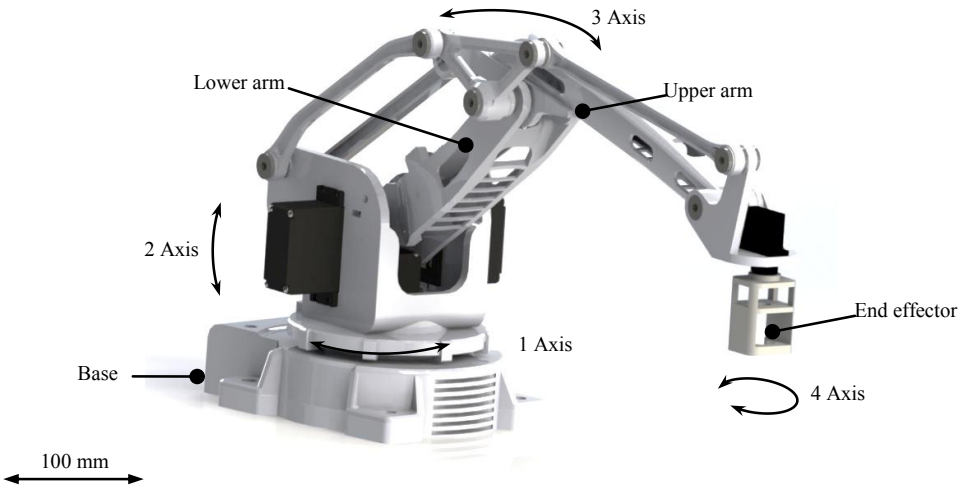

Fig. 1. Robot 3D-Model rendered in SolidWorks.