Active driven prosthesis using a bevel helical gearbox in combination with a brushless dc-motor

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Introduction

In the last two centuries even in the Western Civilization the numbers of limb amputees raised [1]. Main reasons for this are diseases of civilization like diabetes. On the other side many new technological developments in the field of technical rehabilitation devices have been made [2] [3]. Electronically controlled prostheses and orthoses entered the market nearly two decades ago.

Scientists at Fraunhofer IPA developed a new active driven prosthesis for transfemoral amputees using a bevel helical gearbox combined with a brushless dc-motor.

Methods

At the beginning of the development process data from gait analysis from the University Heidelberg have been analysed. To get the right parameters for the active driven prosthesis, these raw data have been used for deriving “characteristic torque-velocity-curves” at Fraunhofer IPA [4]. During the development process different drive-systems in combination with different electrical motors have been tested. Kinematic concepts like different lever-arm-concepts [5] were tested in a specific test rig for active driven prosthesis. Picture 1 shows the test-rig with two integrated kinematic solutions during the development process.

Picture 1: Dynamic Test

Results

An Active driven knee prosthesis and a test rig for active driven prostheses have been developed. The whole prosthesis-system consists of a brushless dc-motor combined with a bevel helical gearbox. Motors from different manufacturer have been tested in combination with different gearboxes. Picture 2 shows a first prototype. During the development process different mechatronic models have been used.

Picture 2: Prototype

Conclusion

With this active driven prosthesis a very high output of torque and power is possible. A maximum torque of 60 Nm is realized in the first prototype-system. Different tests (dynamic and static) have been made. These tests show a very good performance of the prostheses system. Next steps are the integration of a sensor system for the detection of motion and a good and reliable control system based on state-space-control-algorithms.

Literature

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