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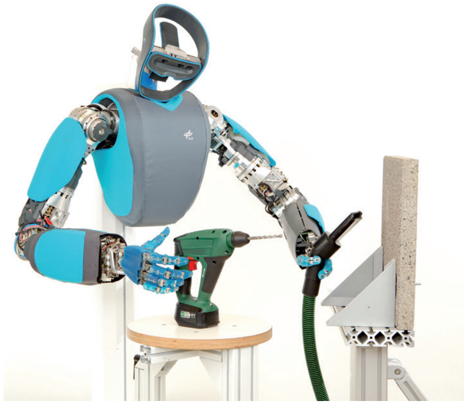
David

Humanoid robot



Brief description

The anthropomorphic robot David is a DLR research robot. It has joints with variable stiffness actuators, which have a mechanically adjustable flexibility in the drive train. One goal in its development is to get closer to human capabilities – especially in terms of dynamics, dexterity and robustness. Not only does David have a size comparable to humans, but he also has a similar range of motion. All joints of the fingers can be controlled individually and thus give the system an extraordinarily high dexterity.

Aims

The robot will operate in an environment designed for human operations. Its humanoid shape should enable intuitive operation and programming.

Parties involved

DLR Robotics and Mechatronics Center

Applications

- Telepresence
- Novel drive concepts
- Artificial Intelligence

Outlook

- Assistance system for human-machine interaction
- Support in dangerous situations
- Maintenance tasks
- Better understanding of humans
- Unstructured environments
- Methods for better grasp planning
- Increase of efficiency

Facts and figures

Size: adult human
Weight: approx. 26 kg
Degrees of freedom: 41
Actuation: 76 brushless dc current motors
Sensors: 165 position sensors
Speed: comparable to humans
Working environment: similar to that of humans

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

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David

Humanoid robot

The robot David is continuously being expanded into a complete humanoid robot. He currently has two arms, a neck and a head. David is to be employed in an environment suitable for humans. For this the robot should resemble a human as much as possible in terms of size, strength and flexibility. David's mechatronic concept is based on powerful and efficient brushless motors combined with highly integrated power and digital electronics. The high-performance hands are slim and light, as their drives are built into the forearms.

David should be able to operate safely in an unstructured and dynamically changing environment. Collisions with objects and obstacles can occur in unknown terrain during normal use. Fast impacts during these collisions often cause damage to the structure or drivetrain of conventional rigid humanoid robots in many situations. This can sometimes lead to the complete cancellation of the mission.

To minimise this risk, in David all 41 degrees of freedom are integrated through variable stiffness actuators (VSAs) with real mechanical springs. These variable stiffness actuators have a high mechanical elasticity. The inherent stiffness in the joints can, like in humans, be infinitely varied by co-contraction of the muscles. The high elasticity in the robot's joints can buffer the collision energy. The spring acts as a mechanical low-pass filter between the gearbox and the output, which reduces torque peaks / force peaks at the output. This leads to increased mechanical robustness.

Another motivation for the development of David is to be able to perform human-like highly dynamic movements. The springs in the VSAs act as energy stores that allow very fast movements to be performed – even faster than the maximum speed of the engines. In addition, the energy efficiency for certain cyclical movements can be increased. With skilful stimulation of the natural vibration behaviour of the system, most of the movement takes place in the springs. The motors and gearboxes, which tend to have high energy losses, must move at a lower speed and deviation than the robot joints. This results in a more efficient overall movement.

Deutsches Zentrum für Luft- und Raumfahrt (DLR)
German Aerospace Center
Sebastian Wolf · E-Mail sebastian.wolf@dlr.de · DLR.de/en