Time-Efficient Design of Cost-Efficient and Task-Specific Robot Systems, Mechanisms, Tools

Tim Lueth's Research
Technical University Munich

Motivation

- Industrial robots are designed for known manufacturing tasks and can be produced in large numbers (such as KUKA, ABB, FANUC)
- The dream to use robots outside of industrial applications is hindered by
  1. the extreme high cost to design a task specific robot system
  2. the high cost of a robot system,
  3. the missing specification of the robot, and
  4. the missing specification of the exact task.

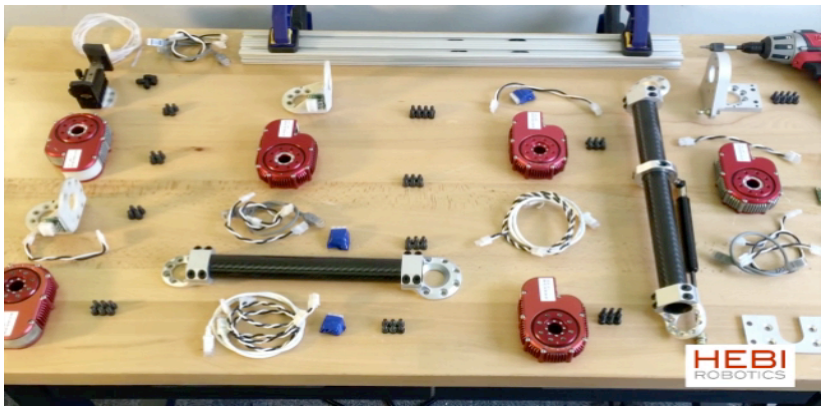
- Especially in surgical applications and for care applications there is a need to design, manufacture and evaluate a robot system during an evolutionary optimization process until a cost-efficient solution can be implemented:
- ➔ Reduce the time to create a cost-efficient robot system

Application

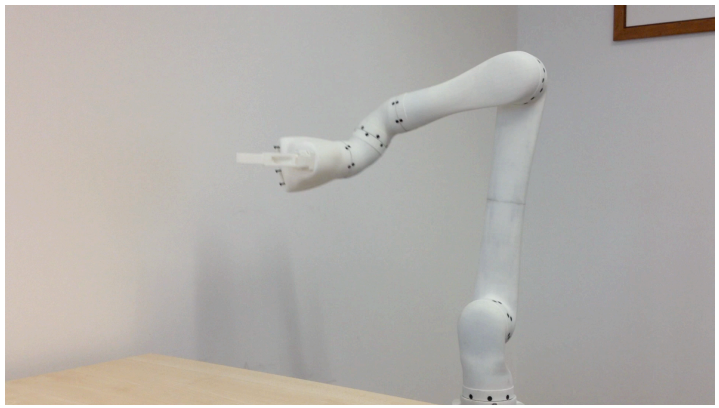
Application: Fast Design, Manufacturing, Control, Programming and Use of Robotic Arms for Research and Evaluation Tasks (*Robotics Tool Kit – Modular Robotics* Systems)

Components: Structure, Joints, Links, Actuators, Power Cable, Communication Cable, Robot Control, Sensor Integration, User Interaction

Example:



Video: HEBI Robotics, CMU, 2015



Video: ErgoSurg, Ismaning, 2013

Reference: [Won, Delaurentis, Mavroidis (2000): "Rapid Prototyping of Robotic Systems", IEEE ICRA

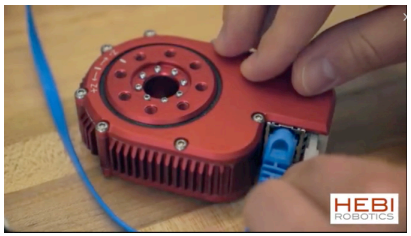
State of the Art

Molecubes Festo 2011

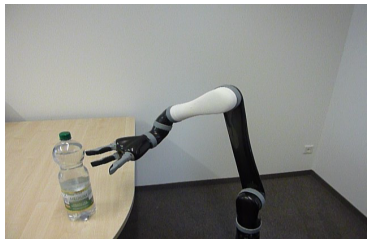
There exist different approaches:

- Modular Robot Systems
- Robotics Toolkits
- Modification of Existing Robot Systems
- Robot Drives with Complete Interface Description

Lego 2015



Hebi Robotics 2016



Jaco ErgoSurg-Kinova 2012

Powerball Schunk 2011

Crucial Disadvantages

Mechatronics know-required for robot design:

1. **Mechanics:** Material, Kinematics, Machine Elements, Rapid-Manufacturing, Mechanism Design
2. **Drives:** Power Supply, Actuators, Power Amplifier, Gears, Field-Bus Control
3. **Electronics**: µC, Real-time Computer System, Sensors, Interfaces (I2C, SPI, …), Circuit Design
4. **Computer Network**: Ethernet, Wireless (WLAN, Bluetooth, Zigbee
5. **Informatics**: Real-time Programming, Embedded Systems, User Interfaces, Task Oriented Interfaces, WWW-Programming

Components with exact and complete interface description are required to connect physics, communication, and control

Software platform is required for modeling and optimization of mechanism and robot design that creates the missing interfaces.