# Manipulation from a hovering helicopter for maintenance tasks: modelling and control

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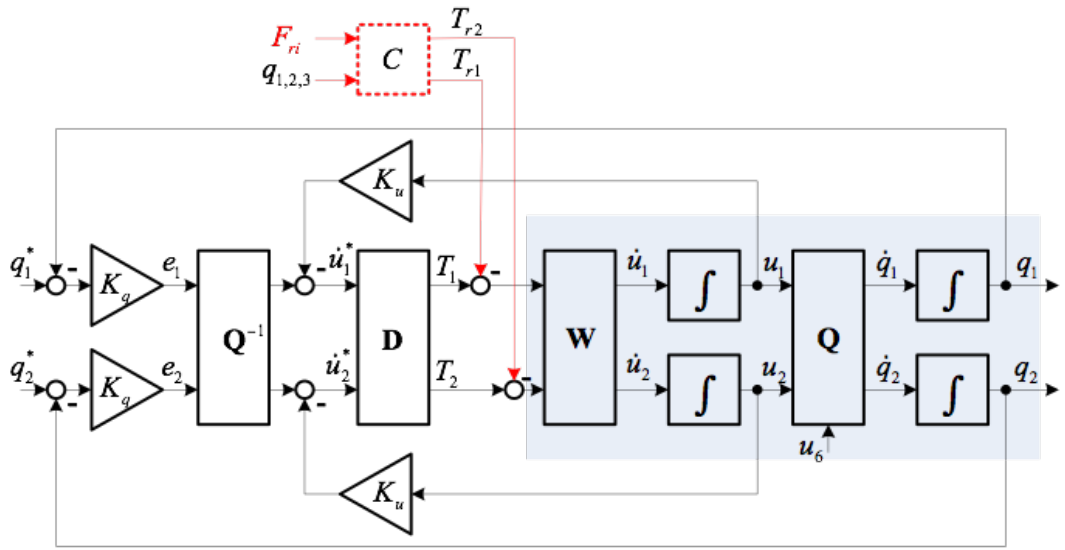
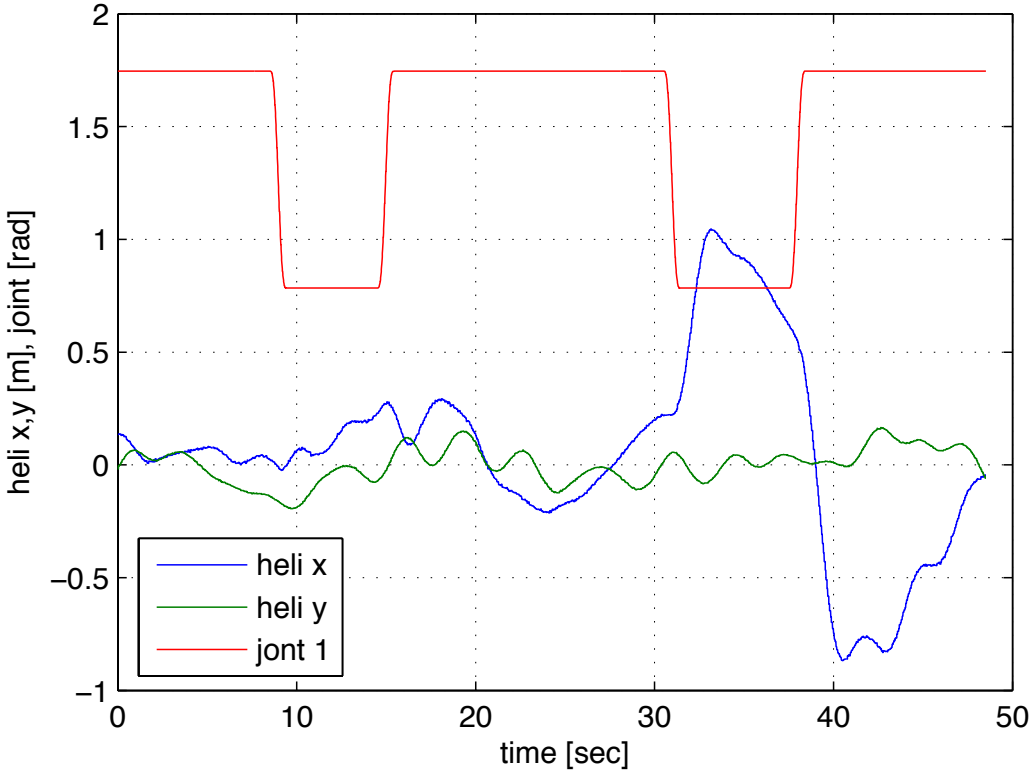
# Aerial manipulation

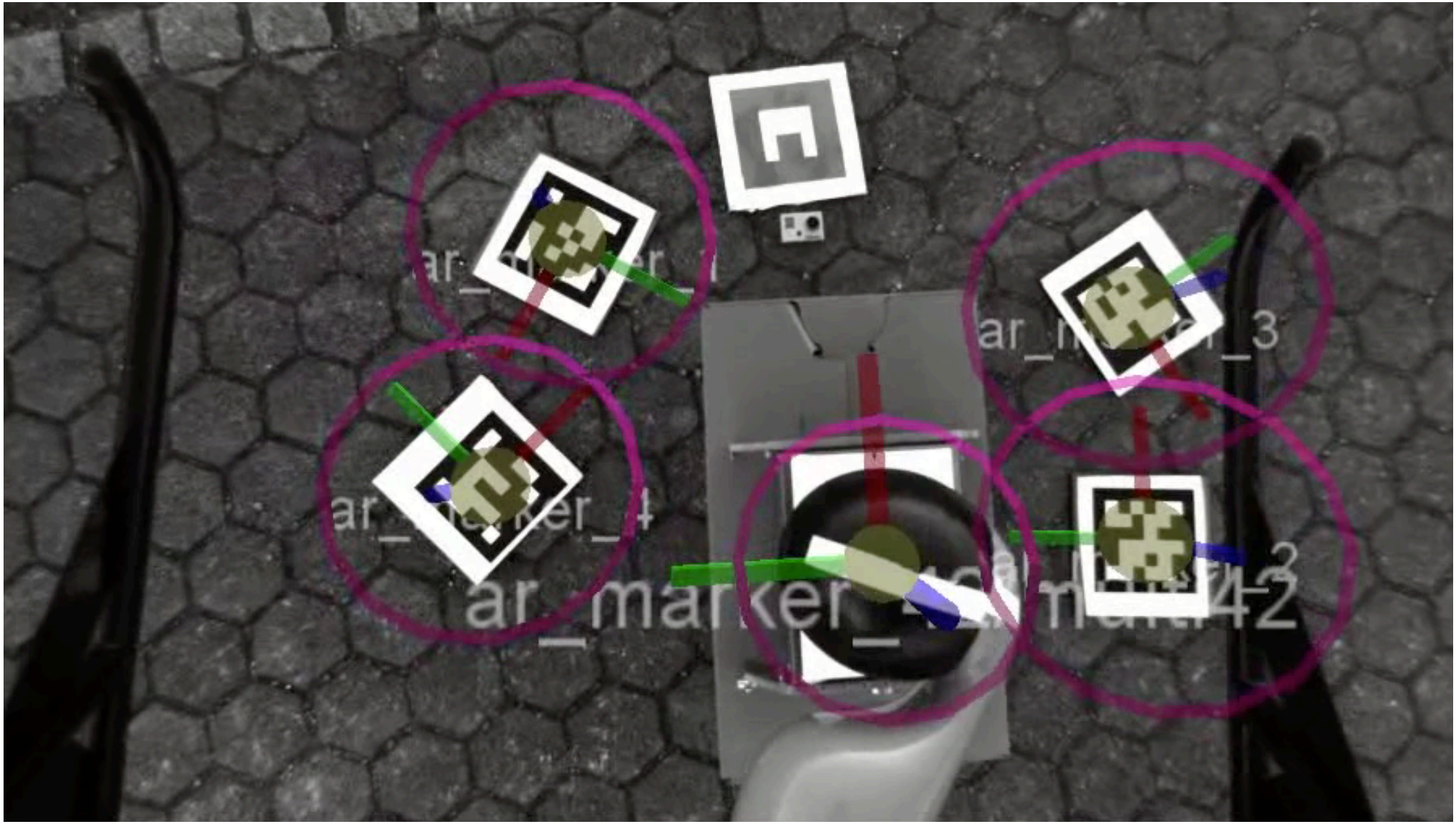
# Arm movement compensation using direct torque feed forward




K. Kondak, F. Huber, M. Laiacker, M. Maier; 2014

# Compensation of time delays using motion prediction



M. Laiacker, F. Huber, K. Kondak; 2015

# Reliable software for complex systems and missions: motivation

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# Teaching and formal verification of the mission sequences (RAFCON)


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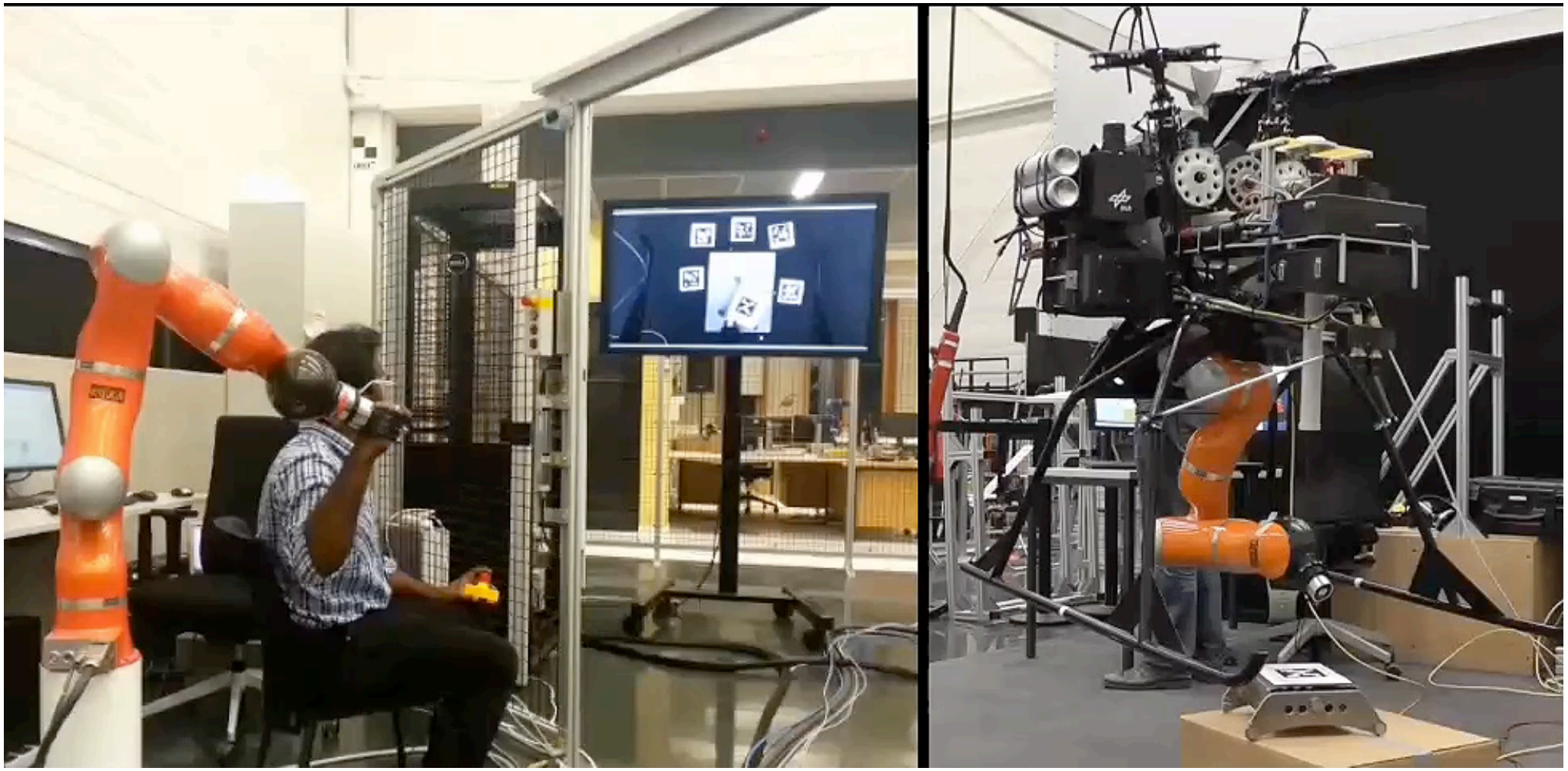
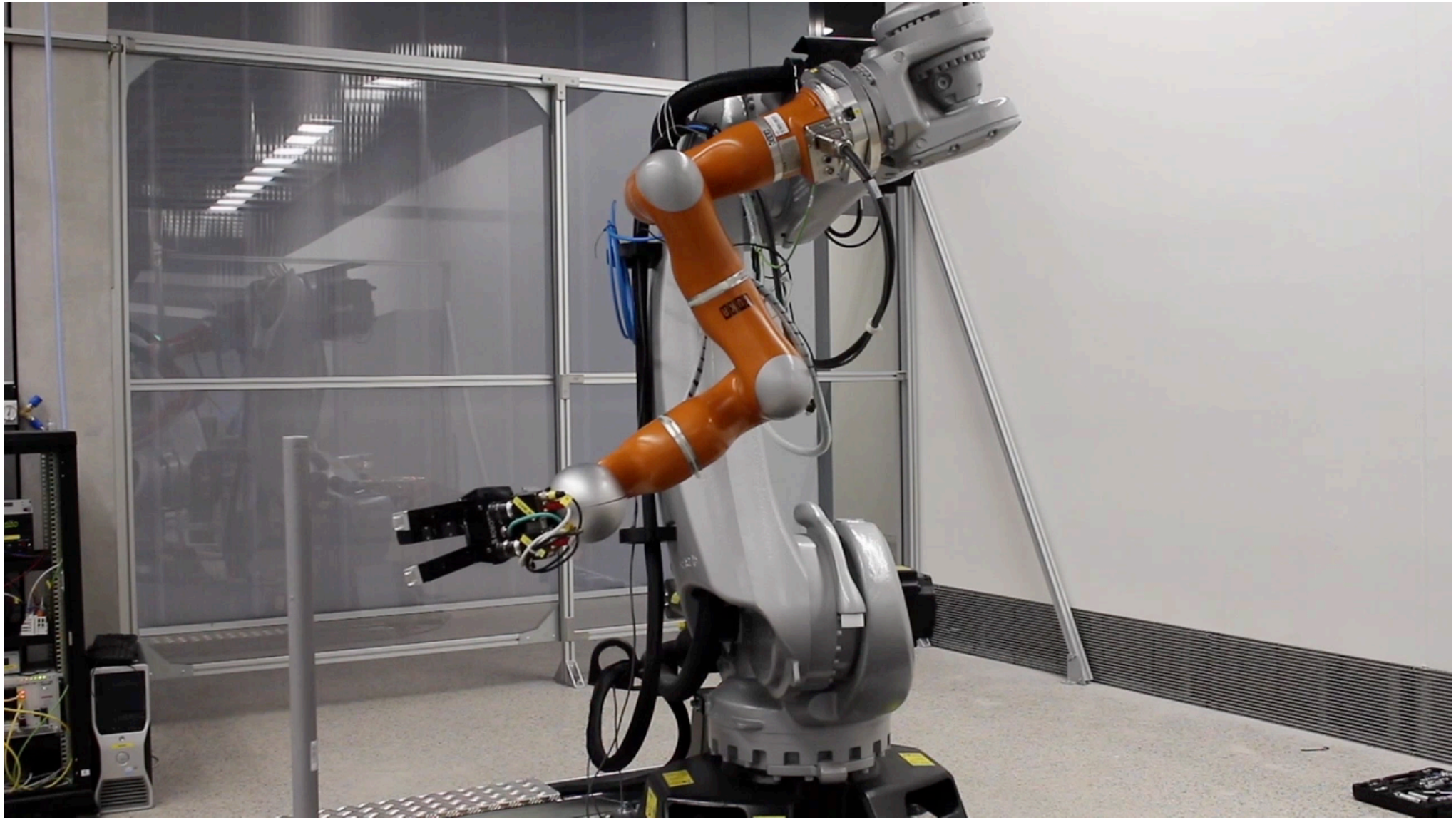
# Aerial manipulation in a real world: target application



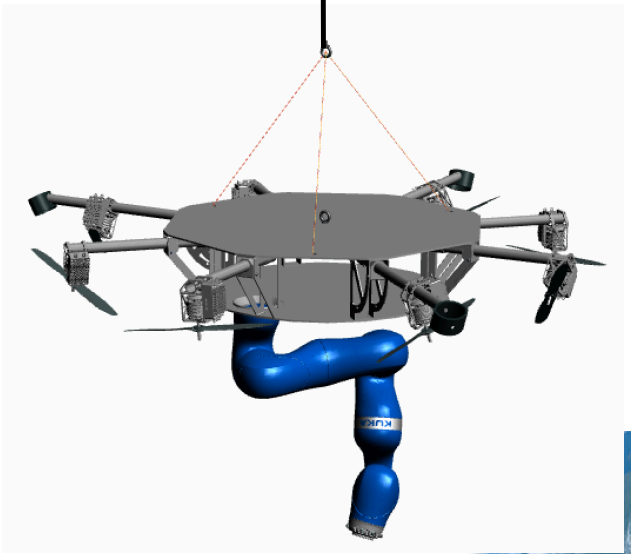
# Advanced technics for simulation



# Applications

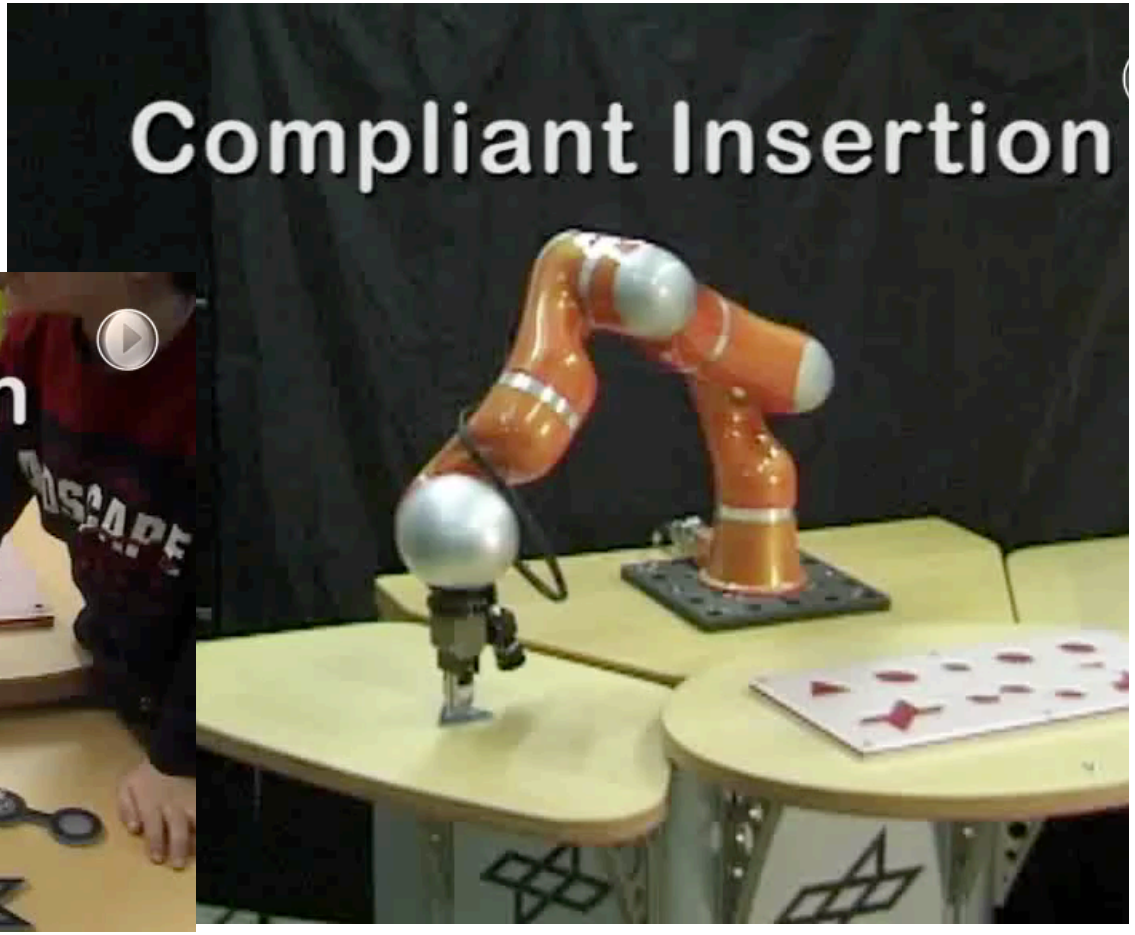
# Alternative system design

20 m



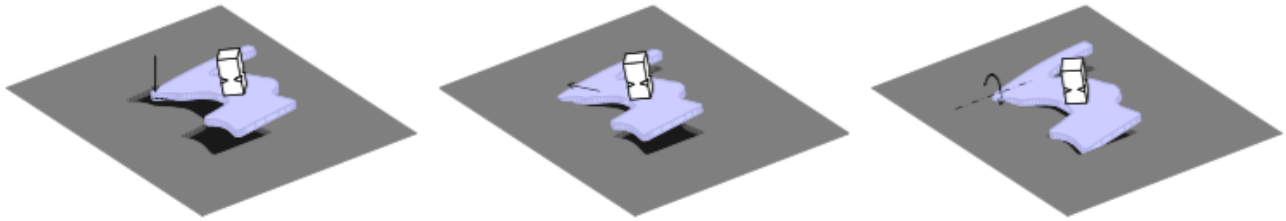
- Safety distance of approx. 10 m between rotor and obstacles is required for helicopter platform

# Robust assembly tasks of planar parts





A. Stemmer, A. Albu-Schäfferr, 2007



(a) immerse first corner (b) align corner (c) immerse second corner

# Conclusions

- Aerial manipulation with helicopter platform and 7DoF industrial manipulator
- Coupling by force-torque interaction as well as by vision based guidance
- Implementation of applications requires combination of different technologies:
  - Tele-manipulation
  - Safety and reliability in system design and operation
  - Task teaching
- Simulation technics as preparation of flight experiments and reduction of their number
- Physical decoupling between helicopter carrier and manipulator platform

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