REMORA:

A **new concept** for **large part** manufacturing without large machine-tool

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LIRMM

REMORA: a Reconfigurable MObile Robot for manufacturing Applications

From basic research to proof of concept

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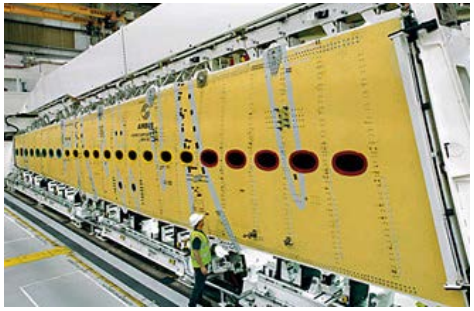
Context: machining of large components

- Aeronautic industry
- Wind power industry
- Train manufacturing industry
- Shipbuilding industry
- …



Airbus Aircrafts' wing box rib
(24 × 3)m

Blade of wind turbine
(30 × 2.5)m

Reaching the limit?

Airbus Automated Fastening Machines
165m long rail

Composite machining

Large work volume processes

- Expensive
- Large footprint
- Facility modification
- Heavy moving parts: +40 tons
- Large energy consumption
- …

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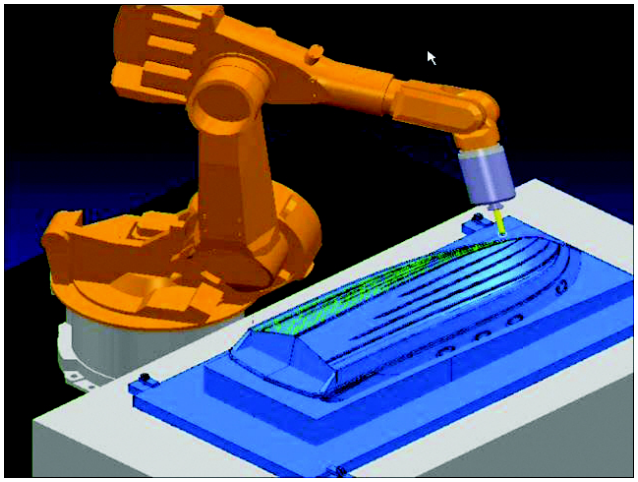
Manufacturing large parts with mobile robotics

Point of view of researchers in robotics:

Propose robots to solve some of the problems



Point of view of machine-tool manufacturers:

Yes, but need to overcome some major problems

- How to enlarge workspaces?
- High rigidity
- Good accuracy in the whole workspace

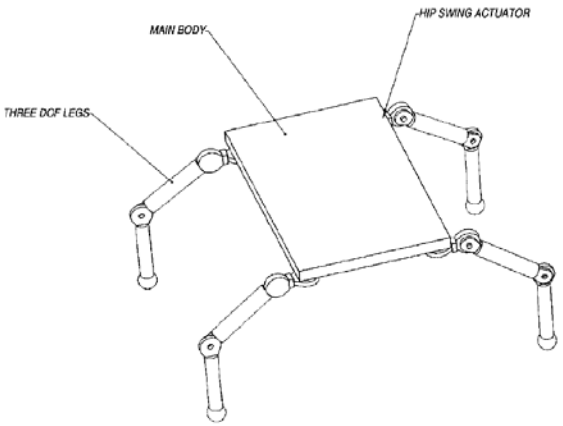
How to overcome these specifications?

Cover large workspaces

➢Mobile robotics

Legged robot used for locomotion

Main characteristic: mobility



Paul E.Sandin, Robot Mechanisms and Mechanical Devices

Applications

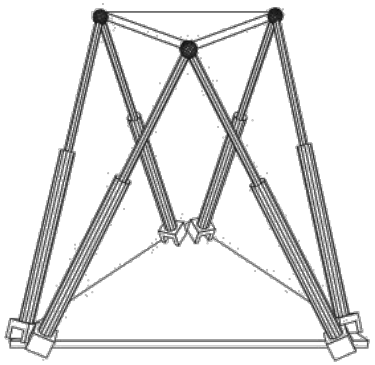
- Exploration
- Demining
- Toys
- …

Provide accuracy and rigidity

➢Parallel robotics

Parallel robot used for manipulation

Main characteristics: payload capacity, accuracy, rigidity, dynamic etc.



Gough platform

Applications

- Flight Simulator
- Machining
- Pick and Place
- …

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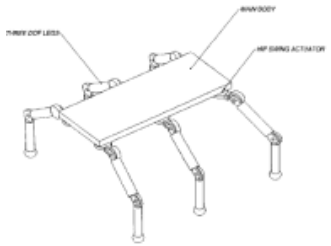
Can we design a walking parallel robot?

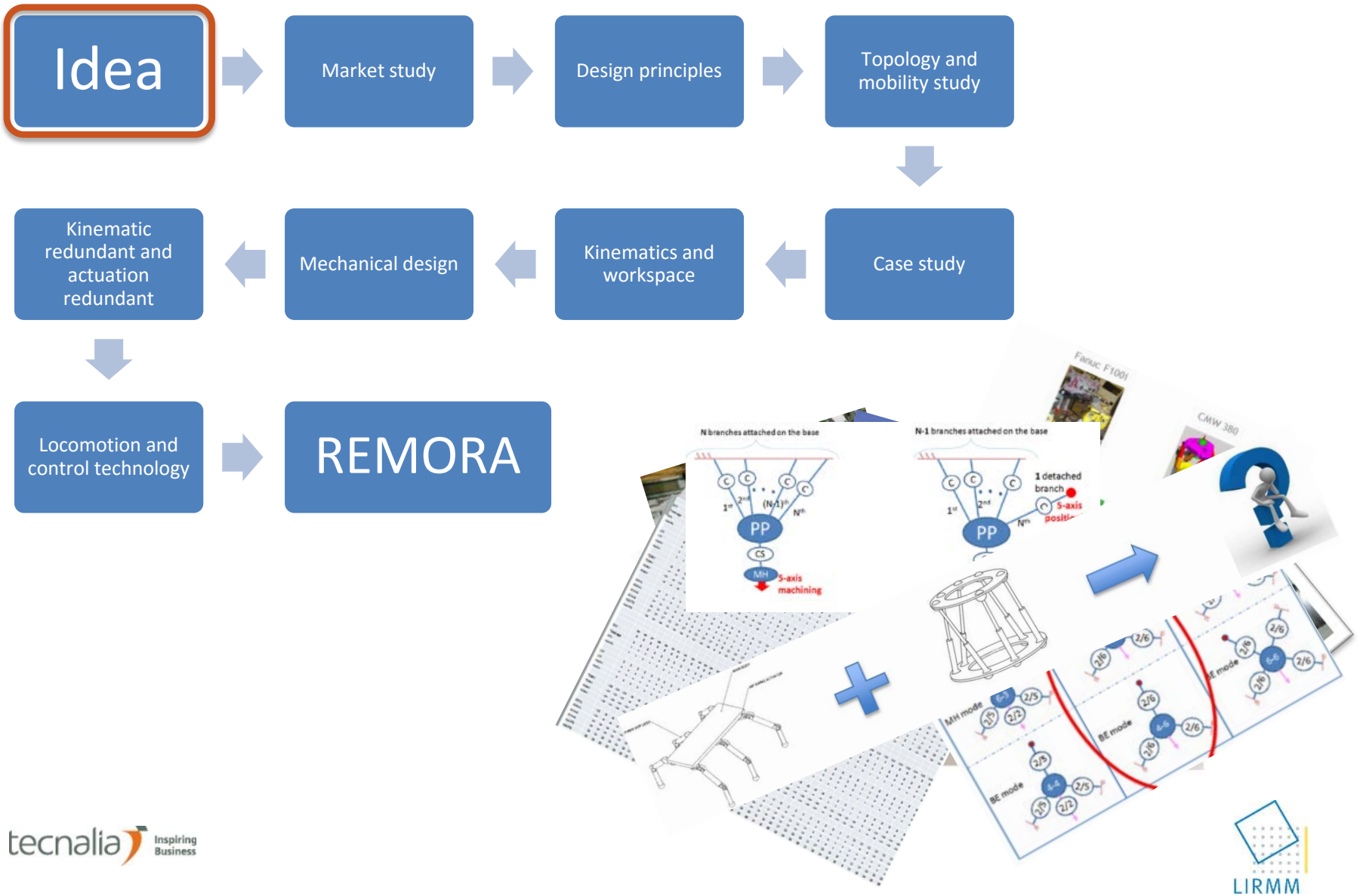


Legged robot

Parallel robot

Walking Parallel Robot

Take advantages of both technologies without drawbacks



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Idea

Market study

Design principles

Topology and mobility study

Case study

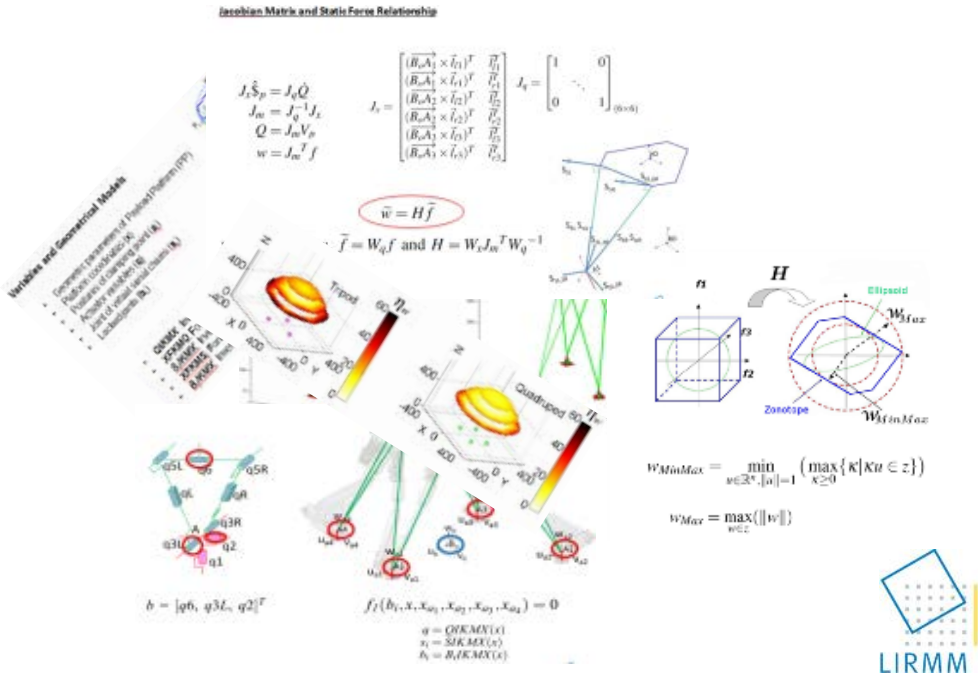
Kinematics and workspace

Mechanical design

Kinematic redundant and actuation redundant

Locomotion and control technology

REMORA



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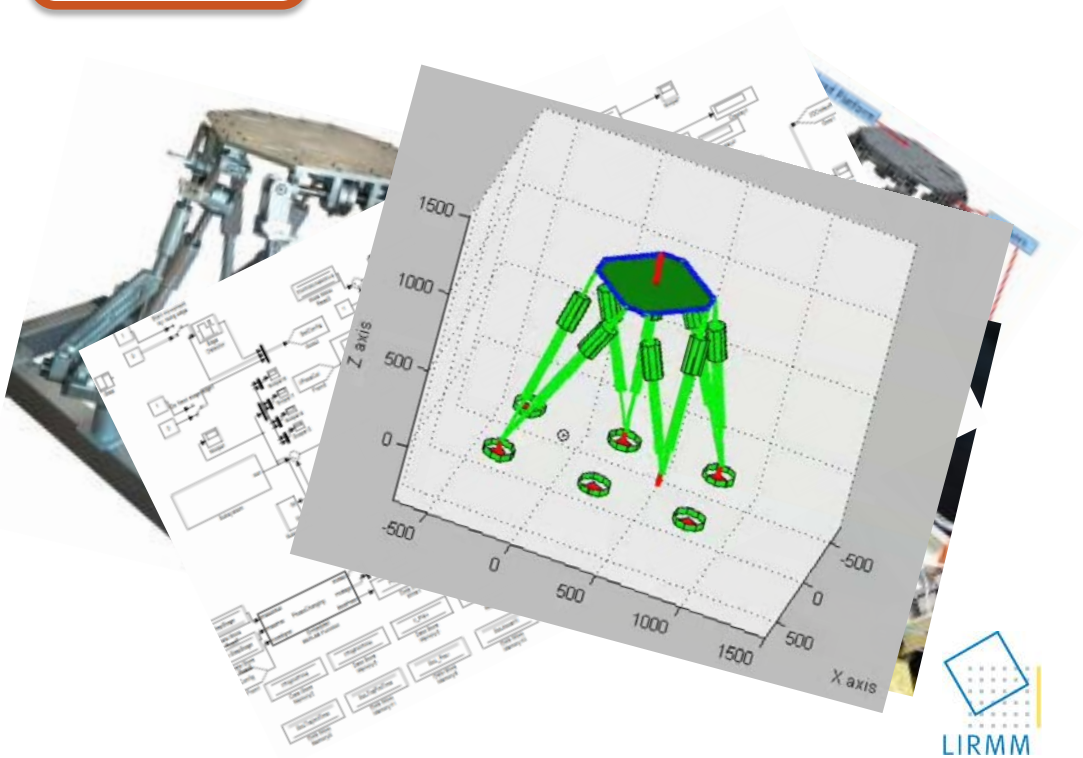

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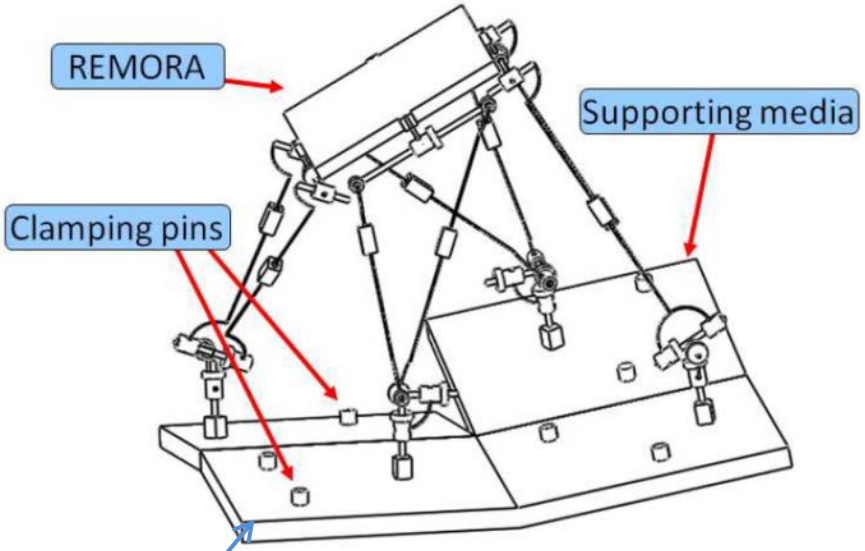
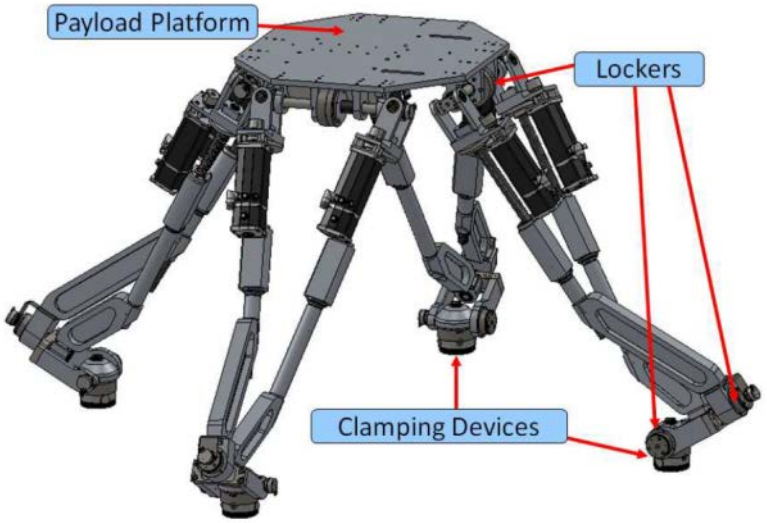
Overall description of REMORA system

Machining phase: **Parallel robot**
Walking phase: **Legged robot**



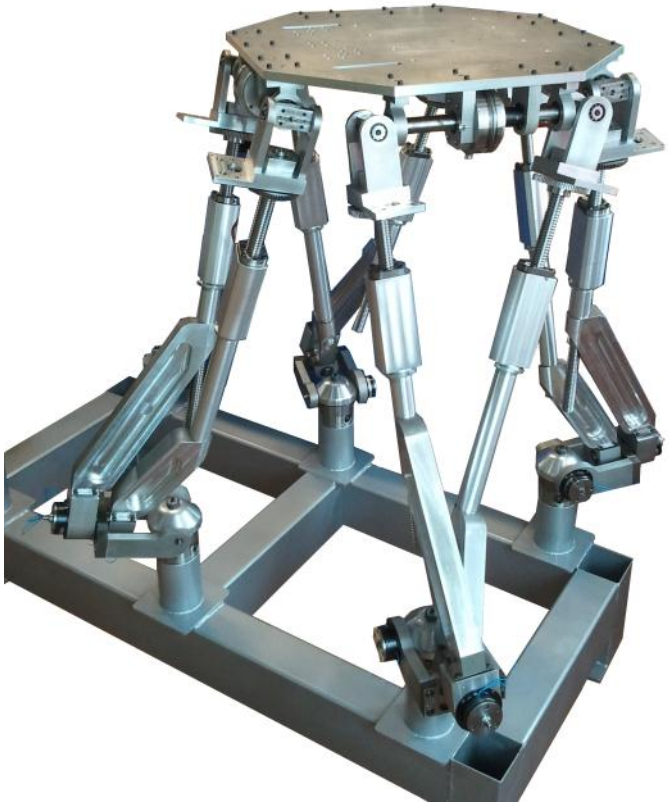
General figure of whole system



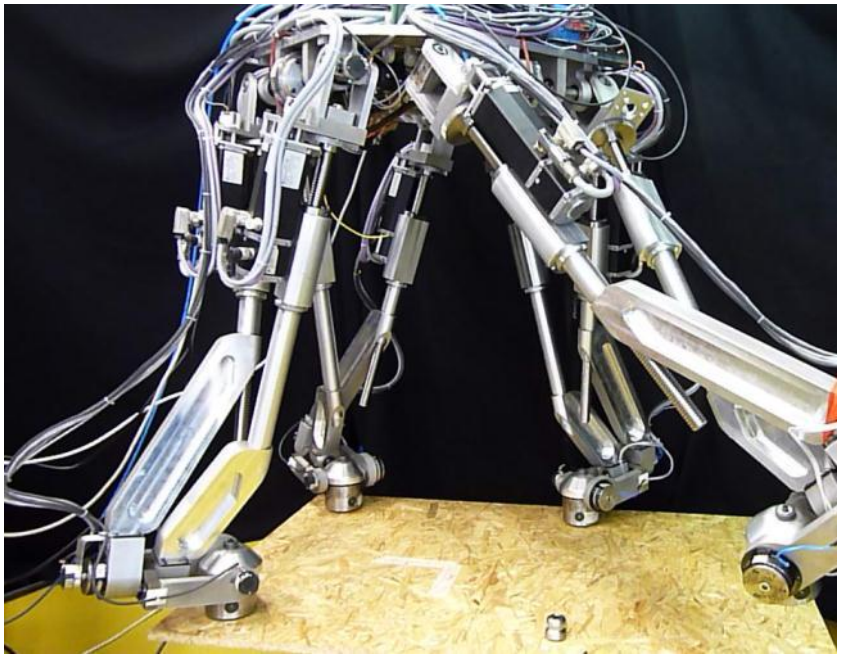
CAD Model of REMORA

Supporting media
- **parts**
- **fixture**
- **workshop**
- **...**

REMORA Prototype



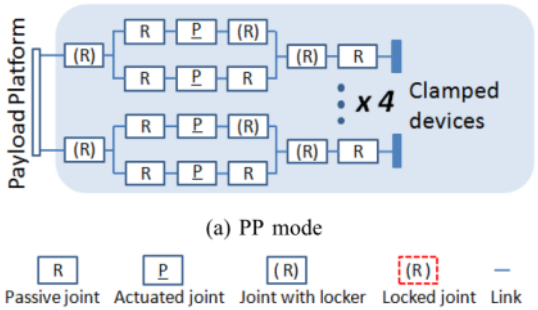
Skeleton of REMORA



REMORA Prototype

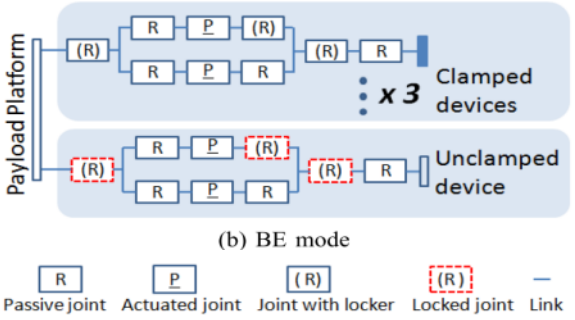
Description of the Walking Parallel Robots

Machining phase: **Parallel robot**



6-dof platform, 8 actuators

Walking phase: **Legged robot**



6-dof platform, 6 actuators
+
2-dof arm, 2 actuators
=
8-dof walking, 8 actuators

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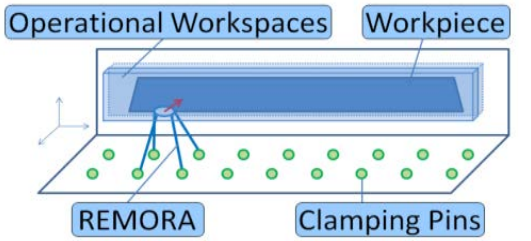
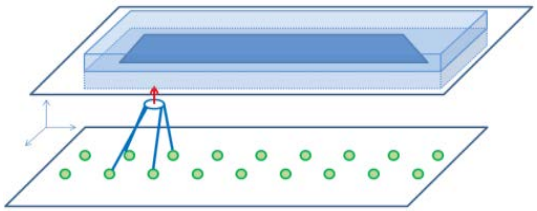
Locomotion Simulation



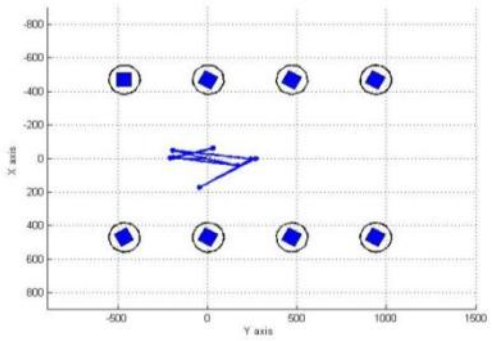
Sideward workspaces



Upward workspaces

Several Workshop Settings

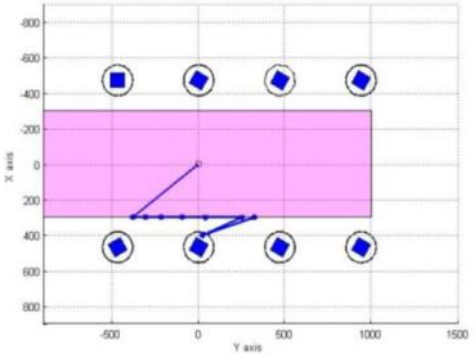
Walking Video 1



Trajectories of center point of PP

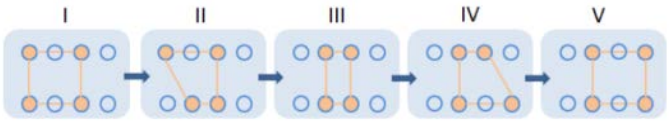
Unconstrained workspace

Walking Video 2



Trajectories of center point of PP

Constrained workspace



Prototype Video

Summary for possible applications:

- large global workspace
- potential for heavy load
- potential for good precisions
- 5-axis tasks
- 5-axis locomotion/clamping
- self-reconfigurable for specific tasks (workspace and force)
- flexible manufacturing (for one parts and for different parts)
- multifunctional (machining, fixtures…)
- …

Clamping pins functions:

- solid connection
- replace guiding structures
- clambering pins (3D frame)
- self-Reconfiguration
- avoid direct localization problem

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Thank you for your attention!

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