Vers la manipulation précise de grandes pièces dans de très grands espaces de travail

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The concept

What does a cable-driven robot look like?

- A Cable-driven robot is a Parallel Robot actuated by cables (CDPR).
- It is mainly composed of:
  - Winches (motor + encoder + drum)
  - Cables
  - Pulleys
  - Platform (anchoring of cables and tool)
  - Controller and drives
- The pulleys permit the routing of the cable from the winch to the desired output point. They can be directly fixed on the building or on a dedicated frame.
- The lengths of the cables are synchronously controlled in order to provide the desired motion of the platform in the Cartesian space.
- The implemented model on the controller takes into account the exact cable routing, sagging and elongation for a better positioning accuracy.
Tecnalia’s expertise with CDPR

Simulation tools

- Analysis of best configuration
- Control simulation
- Dynamic modeling of the platform
- Pre-tension analysis
Tecnalia’s expertise with CDPR

Cable behavior

- Cable modeling - deflection and elasticity
- Real time programming of cables behavior in control

Improvement of positioning accuracy
Tecnalia’s expertise with CDPR

Control of cable robot

• Development of control dedicated to cable robots
• Development of force control

Control algorithm

Management of actuation redundancy
Integration of robot’s dynamics
The benefits

What is a cable-driven robot for?

- **Improving** the **working conditions**
- Guaranteeing the **safety** in the **handling**
- Being able to use the smart crane in **automated mode & manual mode**.
- **Avoiding the swinging** of the parts during handling
- **Reducing** the **setting time** after movements

- **Multifunctional**: wide range of applications in the Aeronautics, Naval, Nuclear industries
  - Handling and assembly of heavy and large parts
  - Handling and positioning of equipment in large structures: for example crawling robots
  - Handling and positioning of end-effectors in large structures for multiple tasks (drilling, riveting, sealing…)
  - Inspection of large workspaces
  - Maintenance: stripping and/or painting tasks
  - Maintenance: substitute telescopic platforms by cable driven platforms
The first research prototypes

**REELAX6 and REELAX8**: Configurable robots of small size

- « Small » size (4m x 3m x 3m), configurable robots (number of drums, cables configuration, ...)

[Images of the prototype robots]
Pre-industrial prototype of medium size

**HRPcable**: Pre-industrial robot to hang (by a thread) an humanoid robot

- Medium size (11m x 4m x 3m), 8 cables
- Industrial controller: Bechhoff
- Payload: 60 kg
Pre-industrial prototype of large size

**COGIRO**: Europe Biggest Cable-Driven Parallel Robot

- Developed by TECNALIA & CNRS-LIRMM
- Footprint: 15*11*6m³
- Payload: 500kg

- Workspace up to 80% of the footprint
- 4mm diameter steel cables
- Industrial controller: B&R Automation
- Mean positioning accuracy: 50mm
- Mean positioning repeatability: 3mm
Industrial applications: Logistics - Handling of parts

Demos performed with Cogiro Prototype

COGIRO. Cable Driven Parallel Robot (Logistics)
https://youtu.be/dmTjrPZqMfo
Cable robots prototypes

- Large size, pre-industrial robot COGIRO
Industrial applications: Handling of heavy and large parts

- Positioning and assembly of aeronautical parts controlling the orientation

COGIRO. Cable Driven Parallel Robot (Large parts assembly)
https://youtu.be/YA2yzc0Vz5w
Cable robots prototypes

- Large size, pre-industrial robot COGIRO
Industrial applications: Assembly of a scaled footbridge of ACCIONA

http://youtu.be/An_i8xoMXDc
http://youtu.be/px8vwNerkuo
Cable robots prototypes

- Large size, pre-industrial robot COGIRO
Industrial applications: Aircraft maintenance operations
Industrial applications: Aircraft maintenance operations

Cable-driven parallel robots equipped with robotics arms for painting and inspection operations

COGIRO. Cable Driven Parallel Robot (Large surface painting)
https://youtu.be/Q05F7Kb96wI
Cable robots prototypes

- Large size, pre-industrial robot COGIRO
Industrial applications: Handling and positioning of end-effectors in large structures
CABLECRANE system is a novel solution patented

Smart crane
- Double-bridge gantry crane with a hoist where all motors are servo-motors computer controlled
- Large workspaces covered
- Heavy loads of several tonnes can be handled

Cable-Driven Parallel Robot – CDPR
- Fully control of 3 displacements and 3 rotations
- No swinging of the load
- Accuracy in positioning
- Load firmly held by 8 cables coming from different directions in a configuration that optimizes the workspace
- Movement in synchronization with the hoist of the smart crane

Available at CEMVISA facilities by the end of 2016!!!
Industrial applications: Handling and positioning of heavy and large parts
Industrial applications: Handling and positioning of heavy and large parts
Thank you for your attention

www.tecnalia.com/robotics