FACULTY
OF ENGINEERING
BILBAO
UNIVERSITY
OF THE BASQUE
COUNTRY

Universidad   Euskal Herriko
del País Vasco   Unibertsitatea

COMPMECH Research Group

Department of Mechanical Engineering
Faculty of Engineering in Bilbao
University of the Basque Country (UPV/EHU)
http://www.ehu.eus/compmech/

Outline

1. About us

2. Research

3. Contracts

About us
Research
Contracts

Where are we
Group
Members

Where are we

Bilbao

- 346,574 inhabitants
- 41.6 km^2
- Metropolitan area:
  - 910,843 inhabitants
  - 500.2 km^2

How to get

- Airport: 15 km away
- Bus: 2 min walking
- Car
- Train/metro/tram
- Ferry: 15 km away

About us
Research
Contracts

Where are we
Group
Members

Group

Belonging to:

- Department of Mechanical Engineering (135 staff)
- Faculty of Engineering in Bilbao (800 staff and $\simeq$ 5,000 students)
- University of the Basque Country (Spain) (5,000 staff and $\simeq$ 47,000 students)
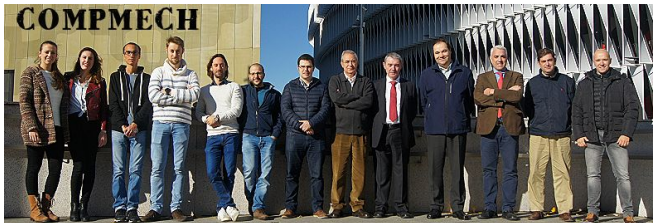
About us
Research
Contracts

Where are we
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Group

Research focused on:

- Basic and applied research
- Design and analysis of parallel manipulators
- Computational mechanics

Web site:

- www.ehu.es/compmech

About us
Research
Contracts

Where are we
Group
Members

Members

Alfonso Hernández

Enrique Amezua

Oscar Altuzarra

Charles Pinto

Víctor Petuya

Erik Macho

Fran Campa

Javier Corral

Mikel Diez

Mónica Urizar

Saioa Herrero

Constantino
Roldán

Antonio Ruiz

Diego Caballero

Additionally:

- 24 MSc./BSc. Students
- Several International Collaborators

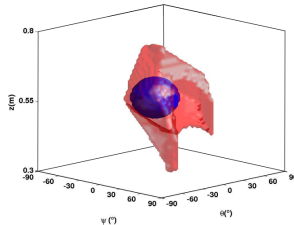# Analysis & Design of Parallel Manipulators

New design methodologies

- Based on:
    - Kinematics
    - Dynamics
    - Workspace
    - Stiffness
    - Natural Frequencies
    - Power Consumption
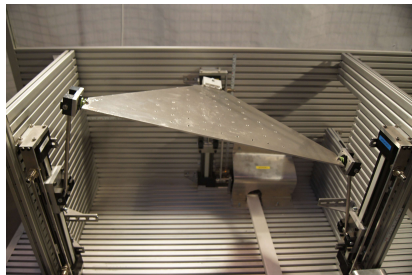
2PRU-1PRS parallel manipulator prototype
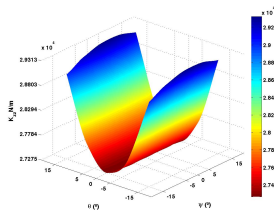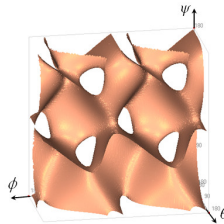

2PRU-1PRS: stiffness

2PRU-1PRS: workspace

Methodology for Cuspidal Parallel Manipulators
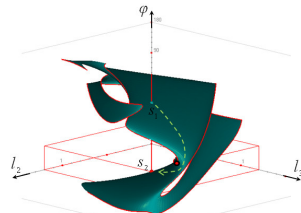
Non-singular transitions in cuspidal PM

- Cuspidal points in the projection of singular curves on the joint space
- Methodology
  - Identification of non-singular transitions
  - Joining parts of workspace → bigger operational workspace
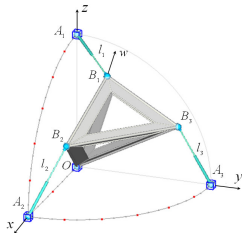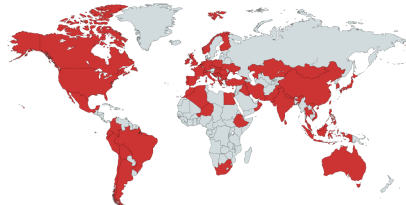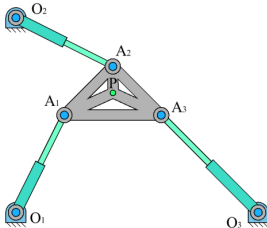

Mechanism

Singularities

Non-singular transitions

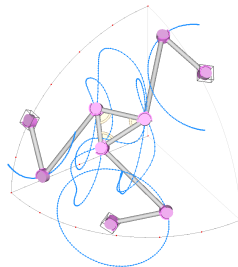# GIM: simulation & analysis software

GIM

- Registered software
- Used all around the World
- Used for:
  - Kinematic & dynamic analysis
  - 2D & 3D mechanisms

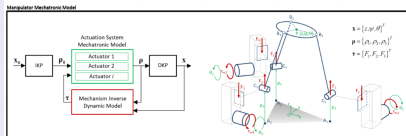Countries where GIM has been downloaded

GIM simulation in 2D

GIM simulation in 3D

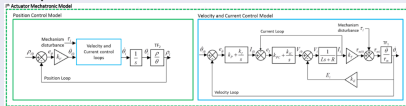# Mechatronics applied to Parallel manipulators

Mechatronics models

- Parallel manipulators
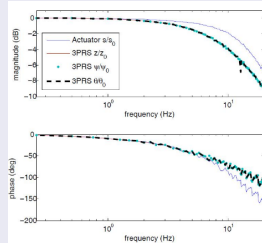- Actuators

Example

Manipulator mechatronic model
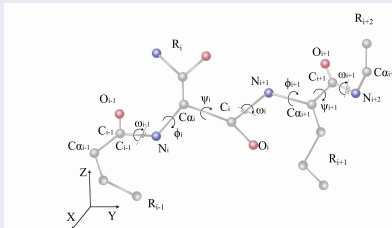

Actuator mechatronic model

Bode diagram with the response of the actuators

Protein Simulation

Application

- Bio-kinematics
- Molecular folding motion simulation based on energy approaches
- Example: Inorganic Pyrophosphatase
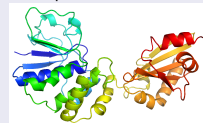
Example: Inorganic Pyrophosphatase

Protein: Inorganic Pyrophosphatase

Initial position

Final position

Modular Design of Reconfigurable Parallel Manipulators

Design methodologies

- Reconfigurable parallal manipulators:
  - Changeable configuration to execute multiple tasks
  - Study of 6 DOF PM
  - Reconfiguring ability by blocking different actuators
  - Simpler machine from the operative point of view
  - Faster and more efficient control
  - Design to achieve the highest number of motion patterns
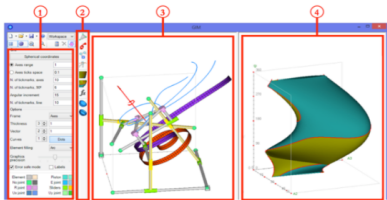
Analysis in GIM

- Kinematic chains library
- Different reconfigurable PM by combining the chains
- Analysis

Ultra Flexible Parallel Kinematic Machines

Flexible PM

- Motion generated by large deformation of elements
- Spatial and planar compliant parallel morphologies
- Several degrees of freedom

Characteristics

- Reduced number of components
- Without kinematic pairs
- Low maintenance
- No lubrication
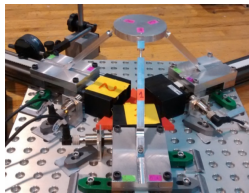- Simpler manufacture and assembly
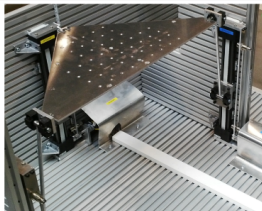- Large range of motion
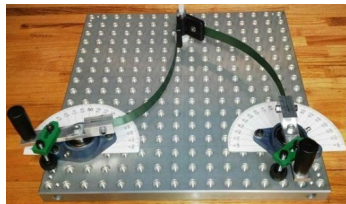
Compliant parallel manipulator

Multiaxial Parallel Kinematic Machines with High Dynamic Capabilities

Multiaxial Machines

- Coupled motion in the end-effector : rotations + translations
- New design methodology proposed based on:
  - Analysis
  - Optimization
- Experimentation & Prototypes
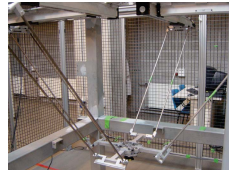

Compliant 3PRS

2PRU-1PRS parallel manipulator

Gough platform

Lower Mobility Manipulators

Characteristics
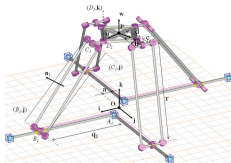- Less than 6 DOF
- Complex kinematics
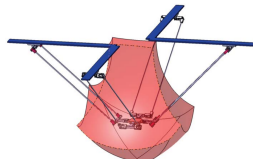

Araba prototype

Design
- Analysis & Optimization
- Performance indices

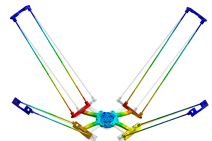## Experimental analysis
- Stiffness
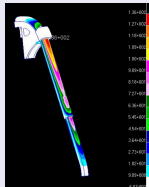- Frequencies/Mode Shape

Manipulator sketch

Workspace

FEM analysis

Contracts

MINOS97
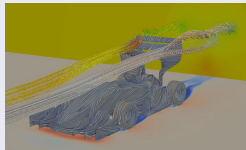
- Wheel chair component analysis

FEM analysis

Prototype

Formula Student

- Design and manufacture of an electric formula vehicle
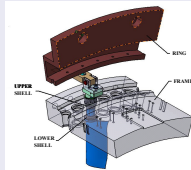

FS 2017: CDF analysis

FS 2016: prototype

Contracts

Openaer

- Smart and active control systems in turbomachines
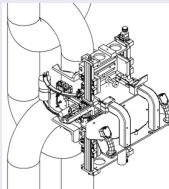

CD model

Prototype

Vicinay cadenas

- Robot for automatic ultrasonic inspection of the welding plane of the stud-less links

Prototype drawing

Prototype

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