System for inspecting and/or treating large surfaces

KEYWORDS

- ROBOTIC INSPECTION
- AUTOMATIC MAINTENANCE
- CABLE - DRIVEN ROBOT
- BRIDGES
- LARGE STRUCTURES

AREA

- CIVIL, CONSTRUCTION & MECHANICAL ENGINEERING

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Patent for invention

Co-Ownership
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Université Gustave Eiffel 14%, Università degli Studi di Cassino e del Lazio Meridionale 15%

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Industrial & Commercial Reference
Sector of inspection and maintenance of civil infrastructure such as bridges and tunnels or facade and large roofs.

Time to Market
TRL 3 – Experimental proof of concept was developed in the EU project DESDEMONA. A pilot project will be presented (12/24 m) to deliver a product in the market

Availability
Cession, Licensing, Research, Develop-ment, Experimentation, Collaboration, Start-up and Spin-off.

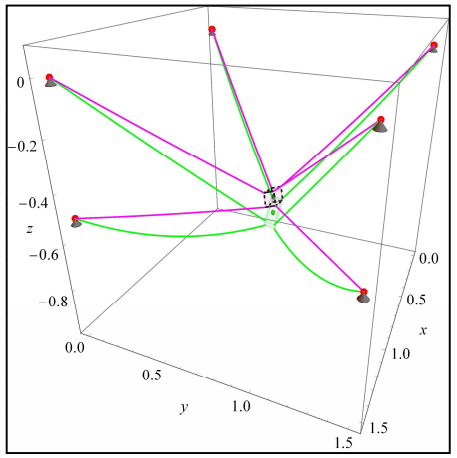

Fig. 1 Geometrically exact three-dimensional model of a cable-driven parallel manipulator: six cables equilibrium configurations for 3D mass positioning. Direct Kinematic (green) vs. Inverse Kinematic (magenta) approach.

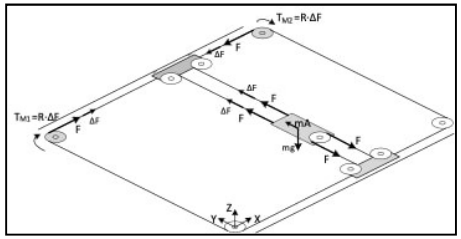

Fig. 2 Sketch of a prototype for a cable robot with 2D workspace.

Abstract
The present invention consists of a robotic system for inspecting and/or treating large surfaces. It is made by moving cables connected to pulleys and to a carrier where can be placed tools for inspection, measurement, and/or treatment. The system is configured to work in a two-dimensional space, for instance a horizontal (i.e., orthogonal to the gravity direction) or vertical plane. The proposed device is able to reach areas with difficult access (e.g., the bottom part of large bridge decks or building facades) and to perform different tasks such as inspecting and detecting possible defects like cracks, fractures, or corrosions, or to perform cleaning procedure and surface treatment.

Publications

- E. Ottaviano, A. Arena, V. Gattulli (2021) “Geometrically exact three-dimensional modeling of cable-driven parallel manipulators for end-effector positioning”. Mechanism and Machine Theory. Vol. 155, n. 104102, pp. 1-20.
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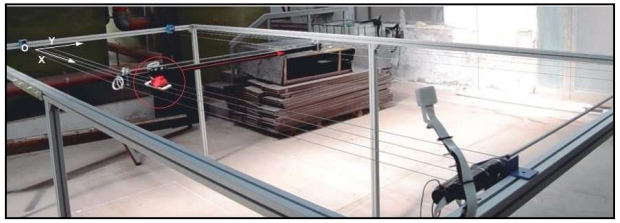


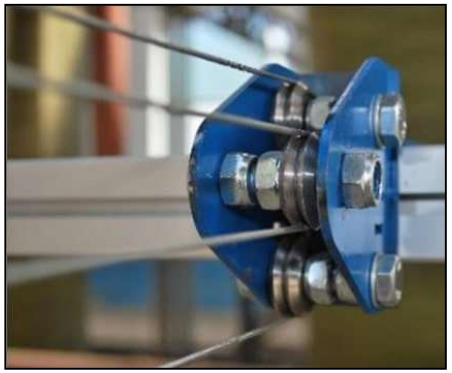
Fig. 3 Experimented prototype of a system for inspection and maintenance of horizontal surfaces.

System for inspecting and/or treating large surfaces

Technical Description

The present invention consists of a system of ten pulleys arranged over a plane and able at moving, through cables, along two orthogonal directions (namely, X and Y directions) a carrier hauling tools for inspection, measurement, and/or treatment. The system is composed of a rigid body (i.e., the carrier) moving along one direction (the X direction) through two pairs of moving pulleys connected to two sides of the carrier. Such pulleys can move along the Y direction by means of a further set of six fixed pulleys and so as to allow the rigid body to span across the whole working plane. All movements are obtained by motors activating two of the six fixed pulleys so that, by rotating in the same sense, provide the movement along the X direction, while, by rotating in opposite sense, the movement along the Y direction is obtained.

Fig. 4 Detail of the used pulley



Technologies & Advantages

A limited number of systems for inspecting and treating building surfaces, facades, structure parts and construction parts are known (e.g., the automatic solution developed for S. Giorgio bridge in Genoa). In addition, these known systems exhibit various drawbacks and disadvantages. In light of the above, it is an object of the present invention providing a system with low-cost features which needs a very low motorization, namely a very low power energy, for the proper functioning thereof. Another object of the invention is to provide a system, which causes, when in use, a very low occupancy of the relevant carrier in the direction orthogonal to the displacement plane of the latter. Another object of the invention is to provide a system, which allows to achieve a high precision for carrier displacements over the whole feasible surface, either horizontally or vertically, to be inspected or treated by such system.
Moreover, the system can be embedded in the structure at the design stage, but also installed on existing ones.

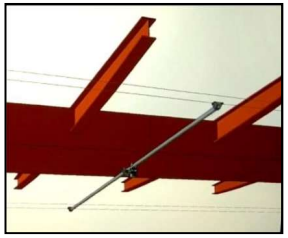


Fig. 5 Design of a system for an inspection of the surface under a bridge deck.

Applications

The proposed invention can be used for the inspection and/or treatment of large surfaces by using a cable system for commanding a carrier element (i.e., an end-effector) where one or more inspection and/or measurement and/or treatment tools are placed. The system is configured to work in a two-dimensional space, which can be a horizontal, orthogonal to the gravity direction (roofing, bridge decks) or vertical plane (pylons, dams, walls). The system is able to reach difficult access areas (the lower part of large dimension bridge decks or building facades) and perform tasks, such as inspecting and detecting possible defects like cracks, fractures, or corrosion, or performing maintenance tasks, such as a cleaning procedure, or surface treatment tasks. The system can be used but not limited to bridges, facades, large surfaces, roofing.

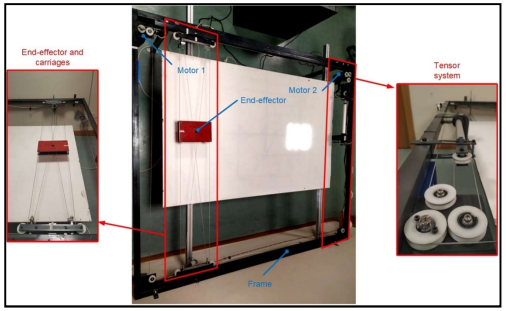


Fig. 6 Experimented prototype of a system for 2D inspection and maintenance of vertical surfaces.

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