A HYBRID-CLIMBING ROBOT FOR STEEL BRIDGE INSPECTION

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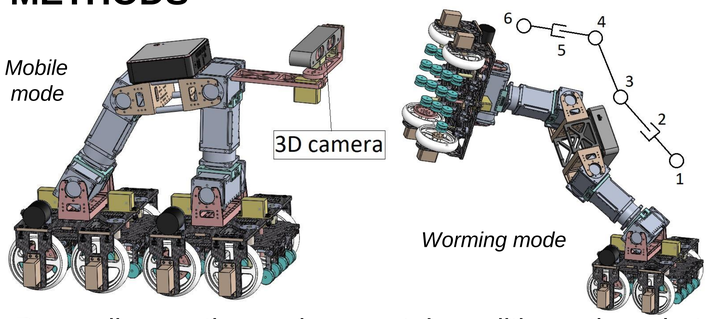
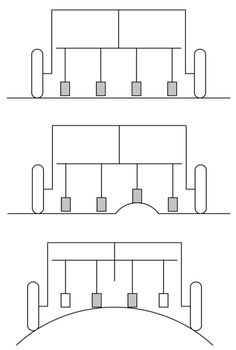
INTRODUCTION

The proposed hybrid-climbing robot is designed of mobile and worming function to traverse areas of complex geometry on steel bridges. The robot utilizes permanent magnets to be able to well adhere on steel structures while moving. A 3D camera collects both visual and point cloud data of environment for inspection and auto control purposes

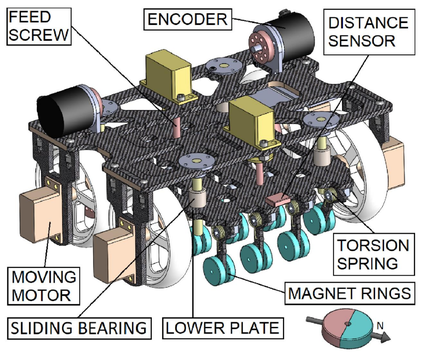
METHODS



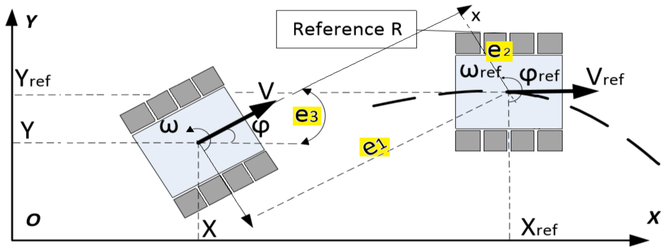
Depending on the environmental conditions, the robot can transform its configuration and switch between its modes of travel. On continuous and smooth surfaces, the robot travels in mobile mode in which the magnet array works in untouched manner. The robot changes its mode of travel to worming mode when a complex steel surface is detected. In this mode, the robot's wheels are locked and will not rotate. Once a new surface is searched for and found, the robot then performs an inch-worm-like jump to the new surface. The magnet arrays are designed with an adaptive function, to modulate the magnets vertical positioning.



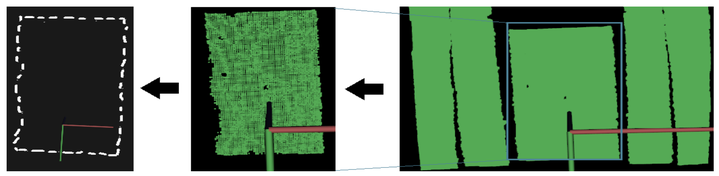
Adaptive function of magnet array on different terrains



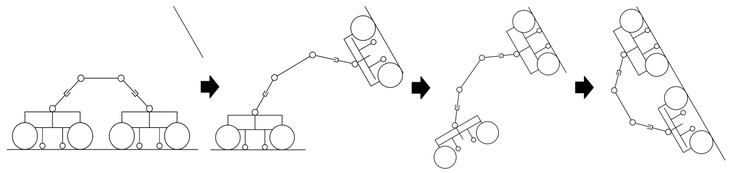
Detail design of robot's foot



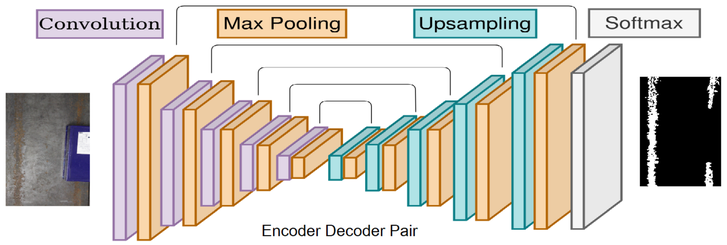
Mobile mode: Robot runs autonomously following path planning algorithms. **Worming mode** is switched to when path planning returns no solutions. The robot looks for a possible new surface by analysing point cloud data of the environment.



A surface with the desired criteria for area, and a feasible robot workspace is searched for and found.



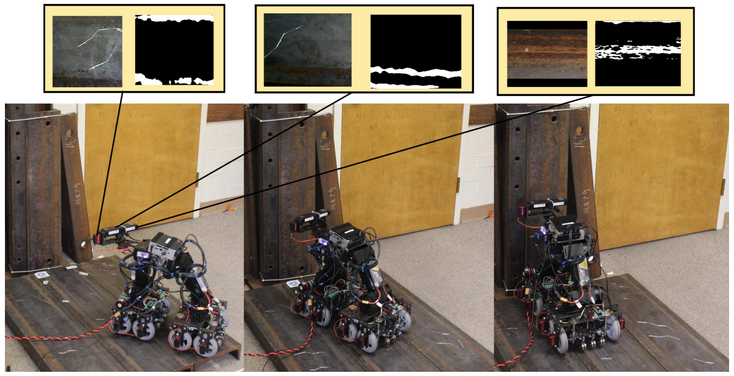
Robot transformation process to move to a new surface



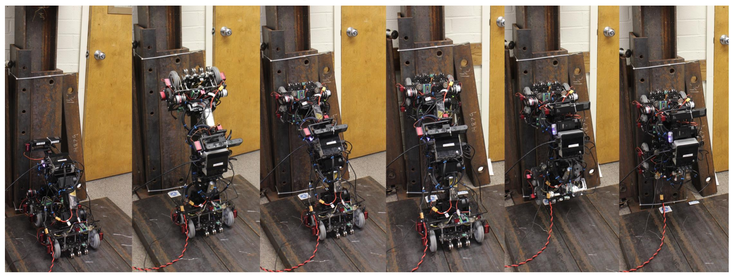
Rust area detection is managed by CNN architecture

RESULTS

Experimental results show that the robot can work well on complex steel structures (flat, curving, paint coasted, nuts). The autonomous control function and visual data processing are tested in an indoor environment. They perform well in that condition.



The robot is following a linear path and doing visual and 3D data collection. In the meantime, real time defect detection is processed parallelly.



The robot is functioning an inch-worm-like maneuver to traverse to a new surface after identifying a suitable area.

CONCLUSIONS

The designed hybrid-climbing robot performs well for steel bridge inspection. This research introduces the mechanical design and control framework in the second phase of our project. In the future, we intend to enhance the robot's functions by improving its stability, data collection capabilities and autonomous capacity and efficiency.

REFERENCE

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