OSWalT - Omnidirectional Spherical Wall Traversing Robot

Visvesvaraya National Institute of Technology , Nagpur India.

Sapan Agrawal, Yogesh Phalak, Sagar Swami, Rajeshree Deotalu, Onkar, Shital Chiddarwar.

INTRODUCTION

Applications in surveillance and building inspections urge the requirement of wall climbing robots which could balance the gravitational force and move close to the surface.

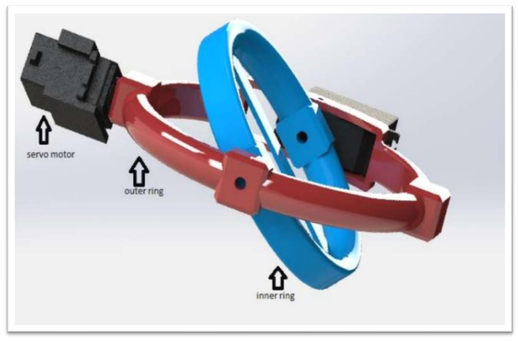
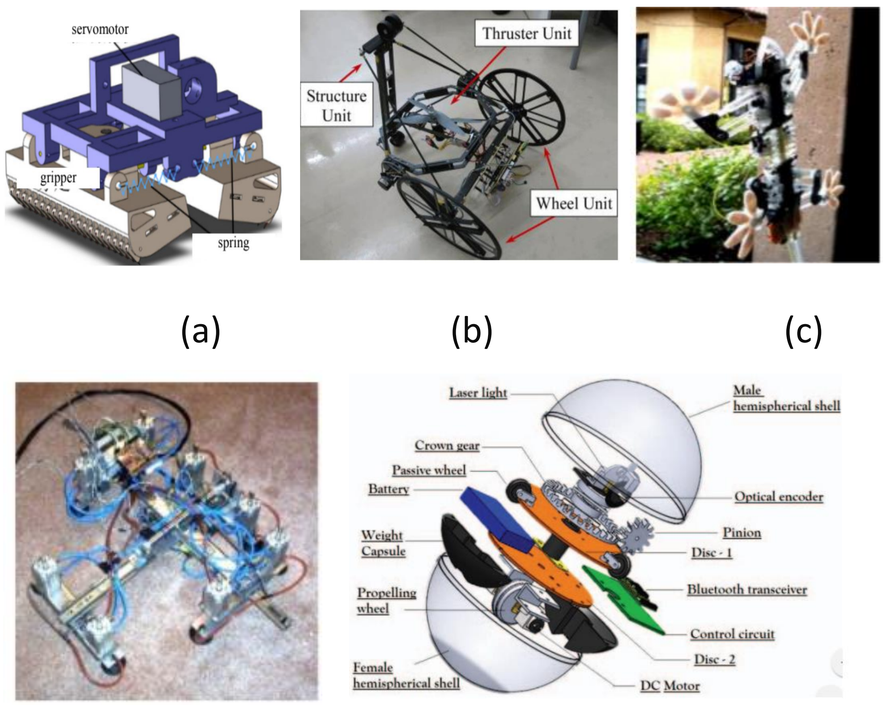


fig 1. Gimble mechanism.

A propulsion based gimbal mechanism is used where required normal reaction for frictional force is provided by the thrust. But such robots are constraint in lateral motion and require large space for turning.

RELATED WORK

Various work has been carried out using mechanisms based on electromagnetic forces, grasping, suction and other to overcome gravity and adhere to walls. But their applications are highly limited to specific purpose.



(a) (b) (c) (d) (e)

fig 2. (a) Bioinspired Wall-Climbing Robot Using Spiny Grippers [1] (b) Wall Climbing Robot with Coaxial Propeller Thruster [2] (c) Gecko-inspired surface climbing robots [3] (d) Miscellaneous designs,(d) BIGGALO wall climbing robot,(e) Omni-directional Spherical Modular Snake Robot (OSMOS) [5]

- The robots based on electromagnetic forces can climb only on ferromagnetic surfaces.
- Robots using vacuum suction mechanism fails to develop sufficient adhesion on dusty and rough walls.
- Other grasping based bio-inspired robots require design of complex mechanism and controlled gait for accurate foot placement

MECHANICAL DESIGN

The mechanical design of the OSWalT consisting of two servo motors and inner ring forming gimbal mechanism. Servo 1 is fixed with Support Frame which is supported by ball bearings in the perforated sphere. Battery is attached to the support frame powering the servos and brushless DC motors (BLDC). Two coaxially placed BLDC motors provide the required thrust. The propellers are attached and rotate in direction opposite to each other to balance the reaction moment while producing force in same direction.

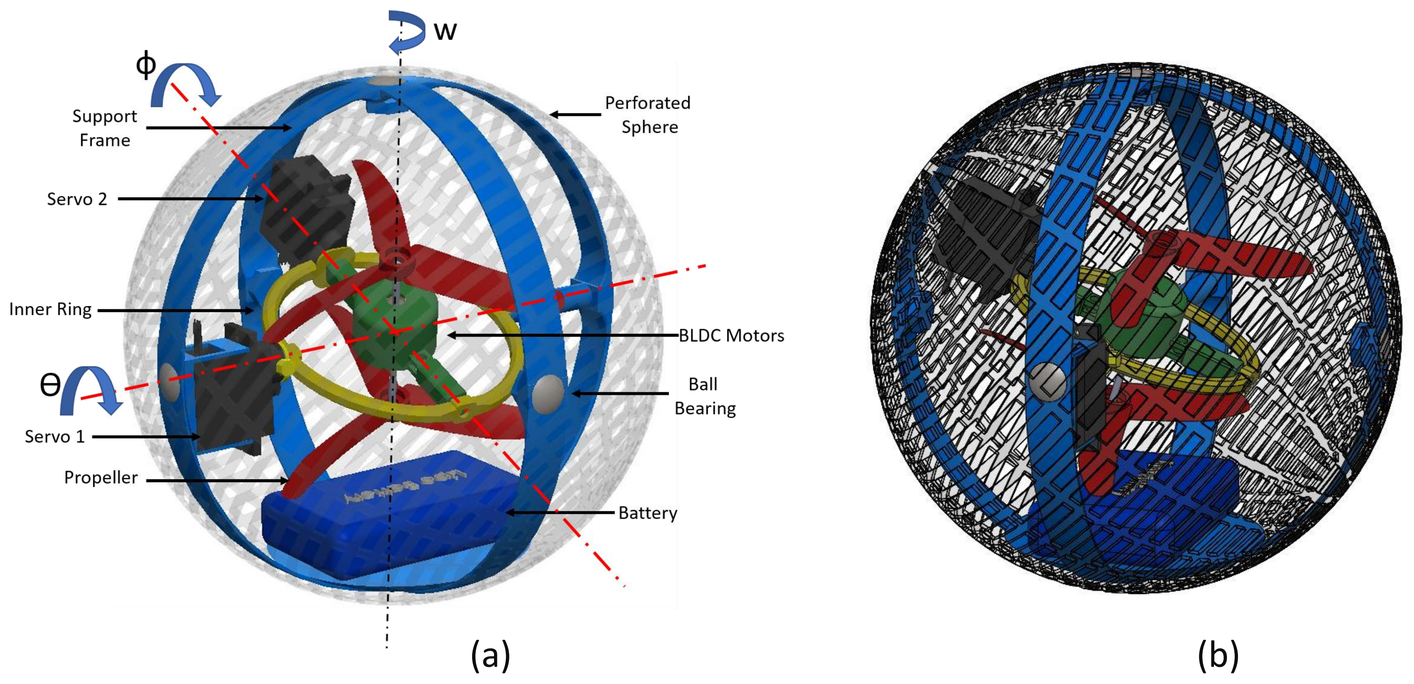


Figure 3. (a) Mechanical design of the OSWalT consisting of two servo motors and inner ring forming gimbal mechanism (b) Final model of OSWalT.

The support frame remains stable in vertical orientation due to mass of the battery producing restoring moment. The ball bearings allow free motion of the perforated sphere in contact with the ground or wall surface. Perforation allows unrestricted flow of air required for producing thrust. The direction of the thrust produced by the propellers is controlled by the two servos. This thrust partly balances the gravitational pull while other provides sufficient normal reaction for the robot to hold its position. Rotating any servo further will enable the robot to climb or move in lateral direction. Hence, a very novel design of wall climbing robot is formed. Experiments and detailed analysis verify the feasibility of the design.

FUTURE WORKS

Future works involve development of working prototype and motion control of the robot.

REFERENCES

[1] G. Liu, Y. Liu, X. Wang, X. Wu and T. Mei, "Design and experiment of a bioinspired wall-climbing robot using spiny grippers," 2016 IEEE International Conference on Mechatronics and Automation, Harbin, 2016, pp. 665-670.

[2] Y. Tanaka, K. Nozaki and K. Ioi, "Motion control of a wall climbing robot with coaxial propeller thruster," 2017 2nd IEEE International Conference on Intelligent Transportation Engineering (ICITE), Singapore, 2017, pp. 360-364.

[3] C. Menon, M. Murphy and M. Sitti, "Gecko Inspired Surface Climbing Robots," 2004 IEEE International Conference on Robotics and Biomimetics, Shenyang, 2004,pp.431-436.
doi: 10.1109/ROBIO.2004.1521817

[4] S. Sano et al., "Development of wall climbing robot using passive joint and vacuum pad on rough surface," 2017 International Symposium on Micro-NanoMechatronics and Human Science (MHS), Nagoya, Japan, 2017, pp. 1-3.

[5] A. Singh, A. Paigwar, S. T. Manchukanti, M. Saroya, M. Maurya and S. Chiddarwar, "Design and implementation of Omni-directional spherical modular snake robot (OSMOS)," 2017 IEEE International Conference on Mechatronics (ICM), Churchill, VIC, 2017, pp. 79-84

ACKNOWLEDGEMENT

- Visvesvaraya National Institute of Technology (VNIT), Nagpur.
- Dr. Shital Chiddarwar – Project Advisor.
- IvLabs- Robotics lab of VNIT, Nagpur.