National Aeronautics and
Space Administration

Robotics, Automation and Control

Amorphous Surface Robots

Multiple techniques for amorphous robotic locomotion

NASA Langley Research Center has developed multiple ways for amorphous robots to autonomously move across a surface without needing conventional wheels or legs. Amorphous robots are useful in dusty and sandy environments in which greater mobility, passive shape changing, and immunity to dust and contamination are important. This includes both surface and subsurface robotic exploration. Amorphous robots are also useful in emergency and industrial activities, such as search and rescue (e.g., exploring rubble following an earthquake) and inspection of oil pipelines or sewage systems.

BENEFITS

- Self-contained and sealed from the environment
- Provides a wheel/leg alternative for locomotion, thus eliminating robot immobility risks associated with locked wheels or legs due to dust or sand accumulation
- Scalable - no restrictions or limitations on robot size

APPLICATIONS

- Search & Rescue
- Pipeline Inspection

technology solution

THE TECHNOLOGY

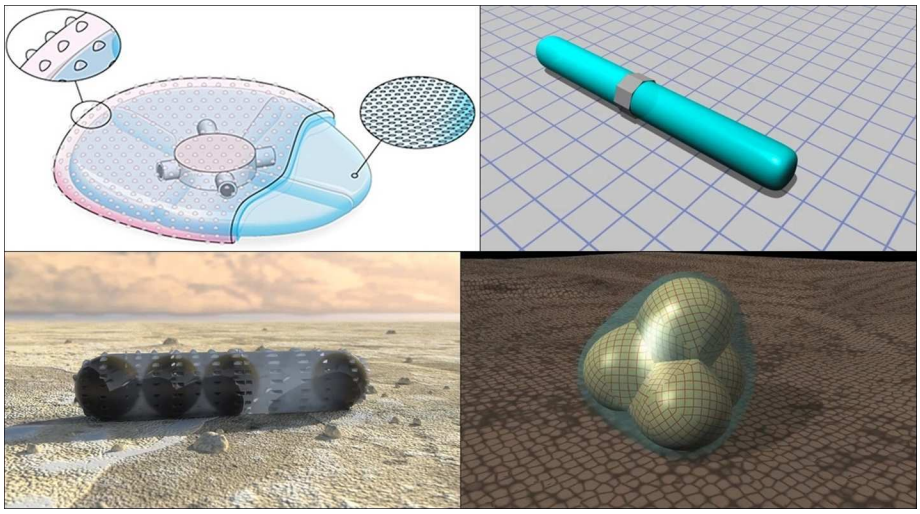
Multiple locomotion techniques are proposed:

Bladder Bot. This design involves a multi-stage process that makes use of a fluid-filled bladder with circulating high-viscosity fluid. Movement of the robot is not based on external moving parts, but rather is caused due to the propulsion of the contained fluid by an internal valve system. The Bladder Bot can be designed as an amoeba (shown below) or with rotating fluid compartments (shown to the right).

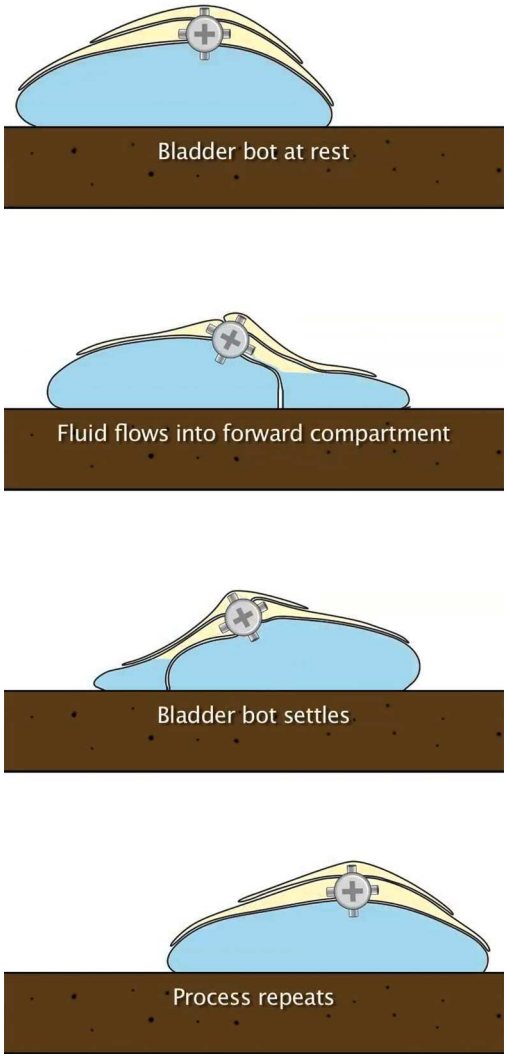
Inchworm Robot. This robot has a tube-like design. Locomotion occurs when internal ferro fluid moves through an electromagnetic ring. The motion resembles the way an inchworm moves.

Electromagnetic Sphere Robot. This design consists of multiple electromagnetic spheres inside a fluid-filled flexible bladder. Motion is initiated when the polarity of the electromagnets are altered sequentially to move the magnetic balls internally, which thus causes the robotic locomotion.

Polymer Cell Robot. The polymer cell robot design consists of multiple polymeric cells encapsulated in a larger flexible outer shell. The cells individually either swell or contract, causing the center of gravity to change, and thus the object rolls accordingly.



Bladder Bot (amoeba design), Inchworm Robot, Electromagnetic Sphere Robot, and Polymer Cell Robot (from left to right, top to bottom).



Bladder Bot with rotating fluid compartments.

PUBLICATIONS

Patent No: 8,662,213; 9,229,451

Patent Pending

More Information

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