Compliant Gripper for a Robotic Manipulator

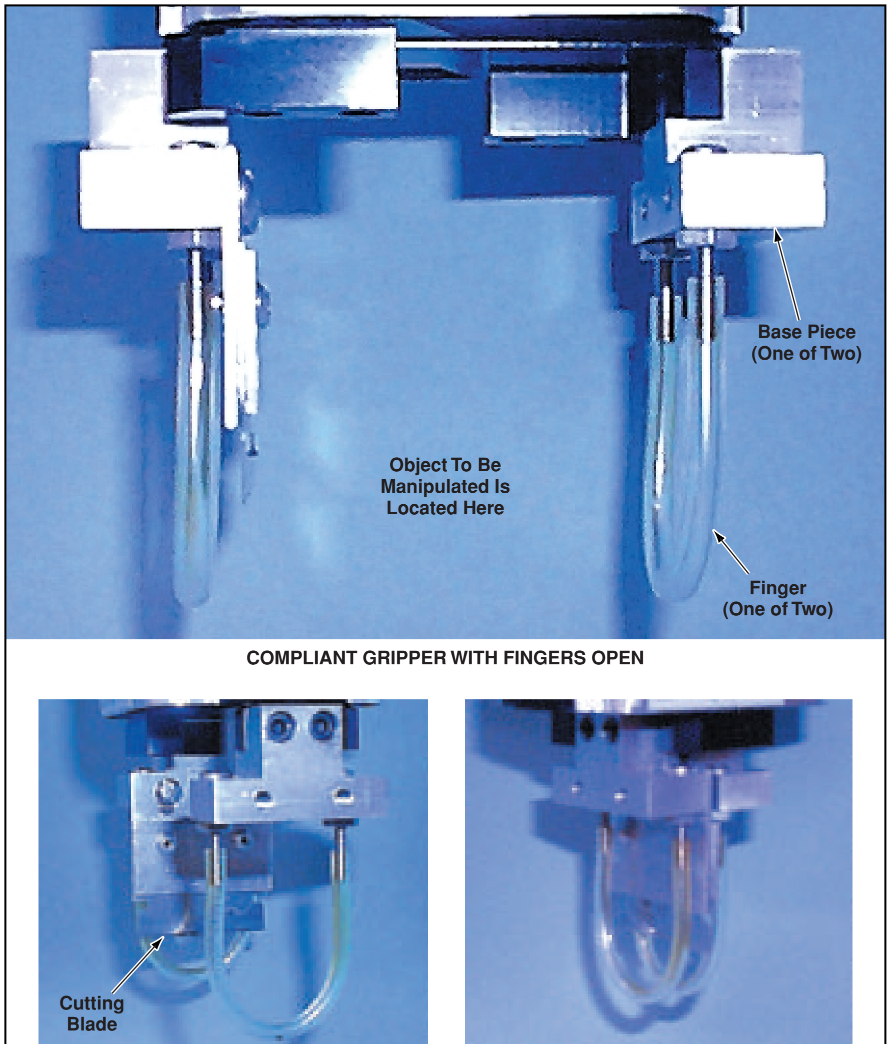
Diverse small objects can be manipulated without force-feedback control.

NASA's Jet Propulsion Laboratory, Pasadena, California

The figure depicts a prototype of a robotic-manipulator gripping device that includes two passive compliant fingers, suitable for picking up and manipulating objects that have irregular shapes and/or that are, themselves, compliant. The main advantage offered by this device over other robotic-manipulator gripping devices is simplicity: Because of the compliance of the fingers, force-feedback control of the fingers is not necessary for gripping objects of a variety of sizes, shapes, textures, and degrees of compliance. Examples of objects that can be manipulated include small stones, articles of clothing, and parts of plants.

The device includes two base pieces that translate relative to each other to effect opening and closing of the compliant gripping fingers. Each finger is made of a piece of elastomeric tubing bent into a U shape and attached at both ends to one of the base pieces. This arrangement of the finger provides compliance, both in orientation and in translation along all three spatial dimensions.

Because the specific application for which this device was designed involves picking up and cutting plant shoots for propagation of the plants, the device includes a cutting blade attached to one of the base pieces. By positioning the device to hold an object, then closing the fingers to grip the object, then driving the base pieces downward toward the object, one can cause the blade to cut the object into two pieces. Because, prior to cutting, the fingers are both holding the object and in contact with the surface on which the object is resting, it is possible to move the base pieces sideways simultaneously to center the blade while keeping the object immobile.



COMPLIANT GRIPPER WITH FINGERS OPEN

ALTERNATE VIEW OF GRIPPER WITH FINGERS OPEN

GRIPPER WITH FINGERS CLOSED

This **Gripping Device** can manipulate and cut a plant shoot or other small object.

The prototype gripper has been shown to be capable of picking up a small object. There is a need to refine the design of the gripper; in particular, there is a need to incorporate a sensor that would measure the position of an object relative to that of the gripper. Other aspects of the design expected to be refined in continuing development include the general problem of gripping, the method of actuation for closing the fingers, the shape of the fingers, fixturing, and cutting.

This work was done by Raymond Cipra, NASA Summer Faculty Fellow from Purdue University, and Hari Das of Caltech for **NASA's Jet Propulsion Laboratory***. Further information is contained in a TSP [see page 1].*
NPO-21104

Hybrid Aerial/Rover Vehicle

This robotic vehicle would combine features of balloons and "beach-ball" rovers.

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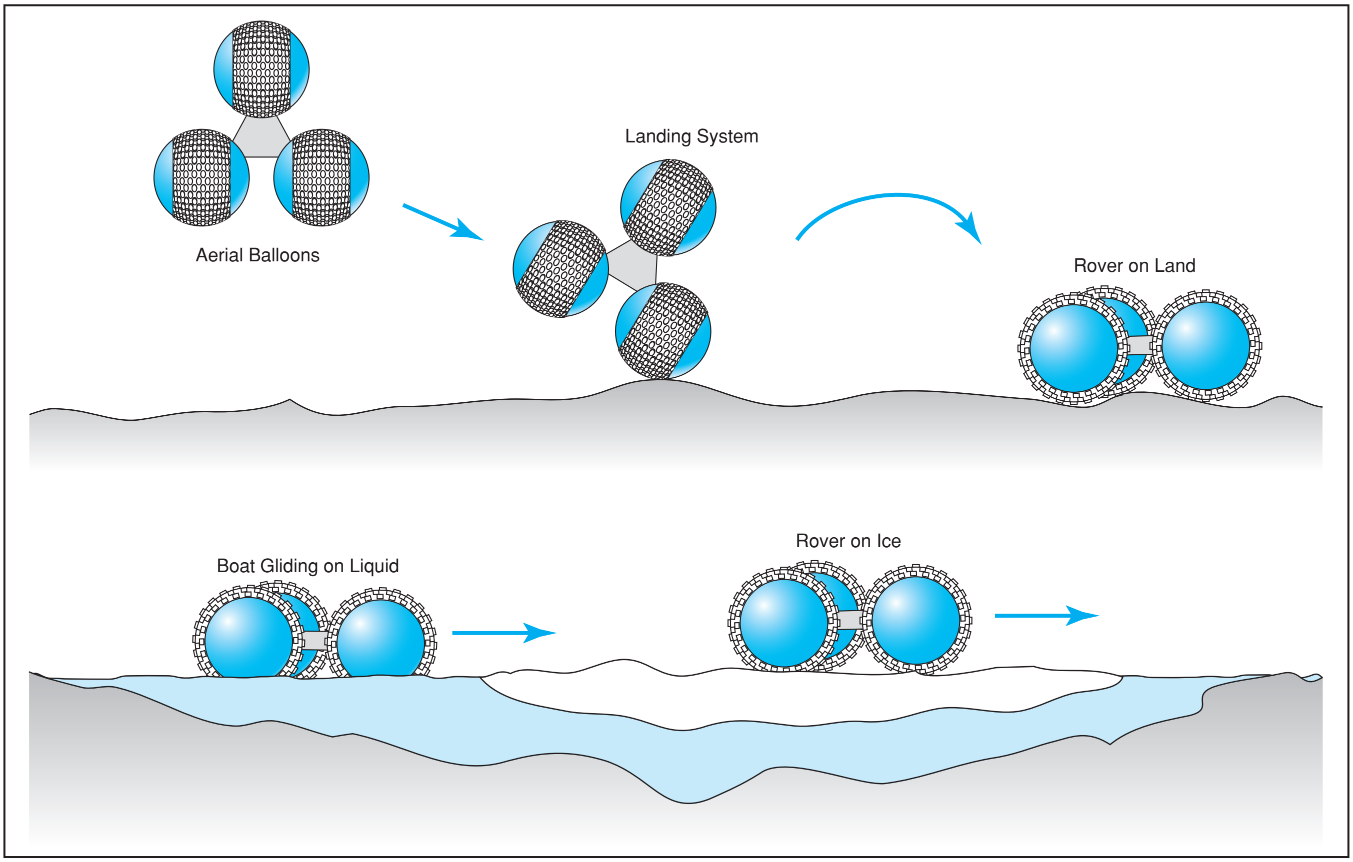
A proposed instrumented robotic vehicle called an "aerover" would fly, roll along the ground, and/or float on bodies of liquid, as needed. The aerover would combine features of an aerobot (a robotic lighter-than-air balloon) and a wheeled robot of the "rover" class. An aerover would also look very much like a variant of the "beach-ball" rovers described in "Lightweight 'Beach-



The **Aerover** would fly, roll on solid surfaces, and/or glide on liquid to acquire scientific data at selected locations along the way.

Ball' Robotic Vehicles" (NPO-20283), *NASA Tech Briefs*, Vol. 22, No. 7 (July 1998), page 74. Although the aerover was conceived for use in scientific exploration of Titan (the largest moon of the planet Saturn), the aerover concept could readily be adapted to similar uses on Earth.

The aerover would include three thick-walled balloons (see figure), each about 2 m in diameter. Initially, the balloons would be inflated with helium to provide lift for flight. Later the balloons would also serve as cushions for landing, as soft tires for rolling over the ground, as flotation bags for traversing bodies of liquid, and as thermal barriers to protect instrument payloads against extreme cold on the ground.

Following initial inflation, the aerover would be set free to drift at a controlled altitude, gathering images of terrain. Altitude control could be effected by (1) heating and/or inflation from a supply tank for ascent and (2) venting helium and/or turning off the heater for descent. From time to time, helium would be vented to make the aerover descend to collect ground samples by use of tethered coring modules or a landing snake. Thereafter, the aerover would make several ascents and descents to acquire additional images and samples.

Eventually, the helium supply would approach depletion; helium would then be vented gradually to effect a final descent. The residual helium in the balloons would provide cushion for a soft landing. Thereafter, the aerover would remain permanently on the surface.

Once the aerover was on the surface, the residual helium in the balloons would be replaced with ambient air. The aerover would then roll along the ground and/or traverse liquid to travel to designated sites, where it would collect highly localized images and samples.

The three-balloon design concept is a fail-safe one. The aerover would be designed so that two functional balloons would provide sufficient lift for ascent. Three balloons would afford redundancy to protect against a failure of one of the balloons. If all three balloons were intact and functioning as intended, then the aerover would have a capability for initial overinflation.

This work was done by Aaron Bachelder of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP [see page 1].*
NPO-20609