

## ✦ DROP: Durable Reconnaissance and Observation Platform

The platform would advance the ability of a soldier or law enforcement person to look ahead or inside of buildings.

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Robots have been a valuable tool for providing a remote presence in areas that are either inaccessible or too dangerous for humans. Having a robot with a high degree of adaptability becomes crucial during such events. The adaptability that comes from high mobility and high durability greatly increases the potential uses of a robot in these situations, and therefore greatly increases its usefulness to humans. DROP is a lightweight robot that addresses these challenges with the capability to survive large impacts, carry a usable payload, and traverse a variety of surfaces, including climbing vertical surfaces like wood, stone, and concrete. The platform is crash-proof, allowing it to be deployed in ways including being dropped from an unmanned aerial vehicle or thrown from a large MSL-class (Mars Science Laboratory) rover.

Platforms that have been deployed either on Mars or in Iraq/Afghanistan are large, have limited mobility on non-flat terrain, and lack stealth. Conversely, many research platforms have become so small that the limitations on range, terrain, and payload reduce their utility. At 100 to 300 grams, there is a sweet spot where a useful payload can be carried (2.4-GHz video camera and microphone), a useful range is possible (100 meters), the platform can be stealthy and persistent (by virtue of small size), and the platform is still light enough to be crash-proof and capable of advanced mobility like climbing and perching.

The goal of the DROP project is to create a robot that is lightweight, durable, and capable of climbing a variety of vertical surfaces. The robot is also designed to transition easily from horizontal to vertical travel, and vice versa, as well as having the ability to scamper over very rough or rocky approaches. Shape Deposition Manufacturing (a specialized multi-material fabrication process) and rapid prototyping (3D printing) were used to create a new climbing mechanism and simple body design to meet these specifications.

The climbing mechanism uses microspine hooks for climbing. These hooks are arranged in a completely new manner on DROP that will allow climbing without complex mechanics or con-



**DROP** has the ability to climb vertical surfaces, including porous surfaces like wood, using microspine hooks.

trols. This same mechanism has the additional benefit of increasing the maximum ground speed.

The body of DROP merges elements necessary for vertical climbing with a design that is compliant and impact-resistant. The main sections of the body are radially symmetric and allow impact forces to be absorbed similarly, regardless of the orientation during impact. The body features multi-material construction for the purpose of being both lightweight and durable. The use of impact-dampening materials, such as polymers in the Shore 20A-60A hardness range, serves to reduce the impact forces on the controls, the parts most susceptible to impact failure. The body design is similar to the “two-wheeled-plus-tail.”

DROP achieves its mobility through the use of wheel-like microspine sprockets. Microspines provide a low-mass, zero-power solution to climbing. For these reasons, microspines are desirable for use in smaller robots. Creating a circular array of these microspines, each with an independent flexible suspension, allows continuous engagement with the climbing surface using a

straightforward, rotary motion. The suspension feature enables each microspine hook to engage the surface independently of other hooks, increasing the chances of multiple engagements. The flexibility of the suspension then allows the microspine hook to remain engaged as the sprocket rotates through a greater range of motion than would otherwise be possible.

The body is constructed from a high-elongation, polyamide-based material and features a two-wheeled design with a tail for stability. The body can be produced quickly and cheaply via selective laser sintering (SLS) from materials that feature high impact resistance. The body is divided into two main components: a central section that houses the motors, and a tail section that contains the batteries, RF receiver, and microprocessor unit. The center and tail sections are connected by alternating sections of SLS material and a polymer of Shore-60A hardness. These alternating sections of hard and soft allow the tail to bend and twist relative to the central section. This flexible connection not only allows the two sections to absorb

impacts independently, but also serves to absorb impacts through its capacity to deform.

Two motors allow the robot to turn in confined spaces and climb with a usable payload. A microcontroller makes it possible to accurately manipulate the rotation of the microspine sprockets. Doing so enables DROP to use one motor control algorithm for ground travel at high

speed and another for more controlled, secure climbing.

*This work was done by Aaron Parness and Clifford F. McKenzie of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).*

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