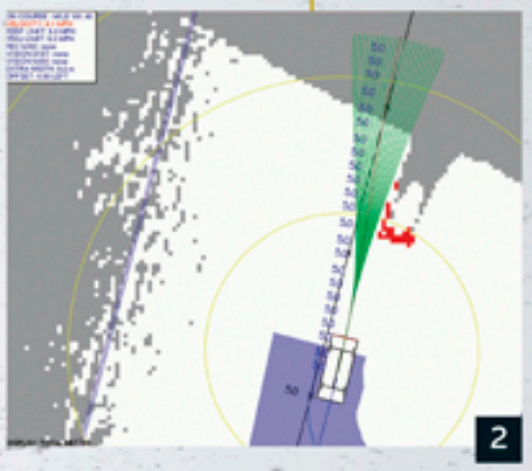
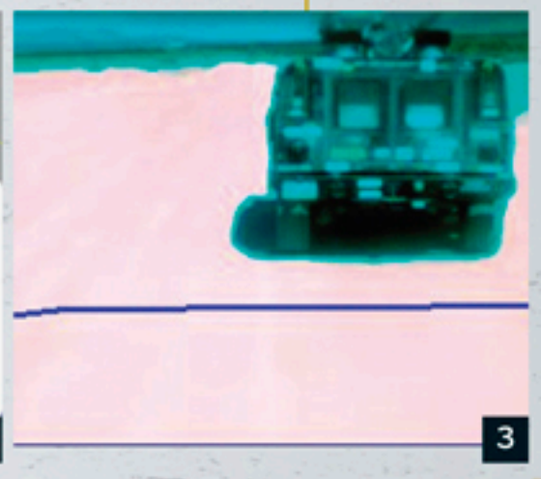
OFF-ROAD AUTONOMY





How Stanley's Sensors See the Road
Here, Stanford's self-driving vehicle prepares to pass a robotic Hummer, represented by red and green lines on a 3D terrain map plotted by a light detection and ranging system **(1)**. The Mapper program interprets the map as a grid **(2)**: White cells mean driveable road; red cells, an obstacle; and gray cells, unknown conditions. The Planner then plots safe route options, marked by green lines, around the obstacle. A video camera **(3)** samples Mapper-defined "good" road (below blue line) and searches for similar-looking terrain ahead.

Race Course

The 131.6-mile DARPA race course snaked through Nevada's Mojave Desert. Stanley's gauntlet included cliffs, three tunnels (**a**) and Beer Bottle Pass (**b**), as well as competitors like Carnegie Mellon's Hummer (**c**).

Computers

On race day, two Pentium M processor boards controlled driving, another handled vision systems and one logged data. Two more served as backups.

Automatic Transmission

Electronically controlled hydraulic arm manipulates the automatic shift lever. Manual override safety switches are below, on center console.

Steering Mechanism

Electric motor spins a sprocket, driving a motorcycle-chain linkage around the steering column at speeds up to one full wheel revolution per second.

GPS Navigation

Three GPS receivers provide data on position, pitch and heading.

Inertial Guidance

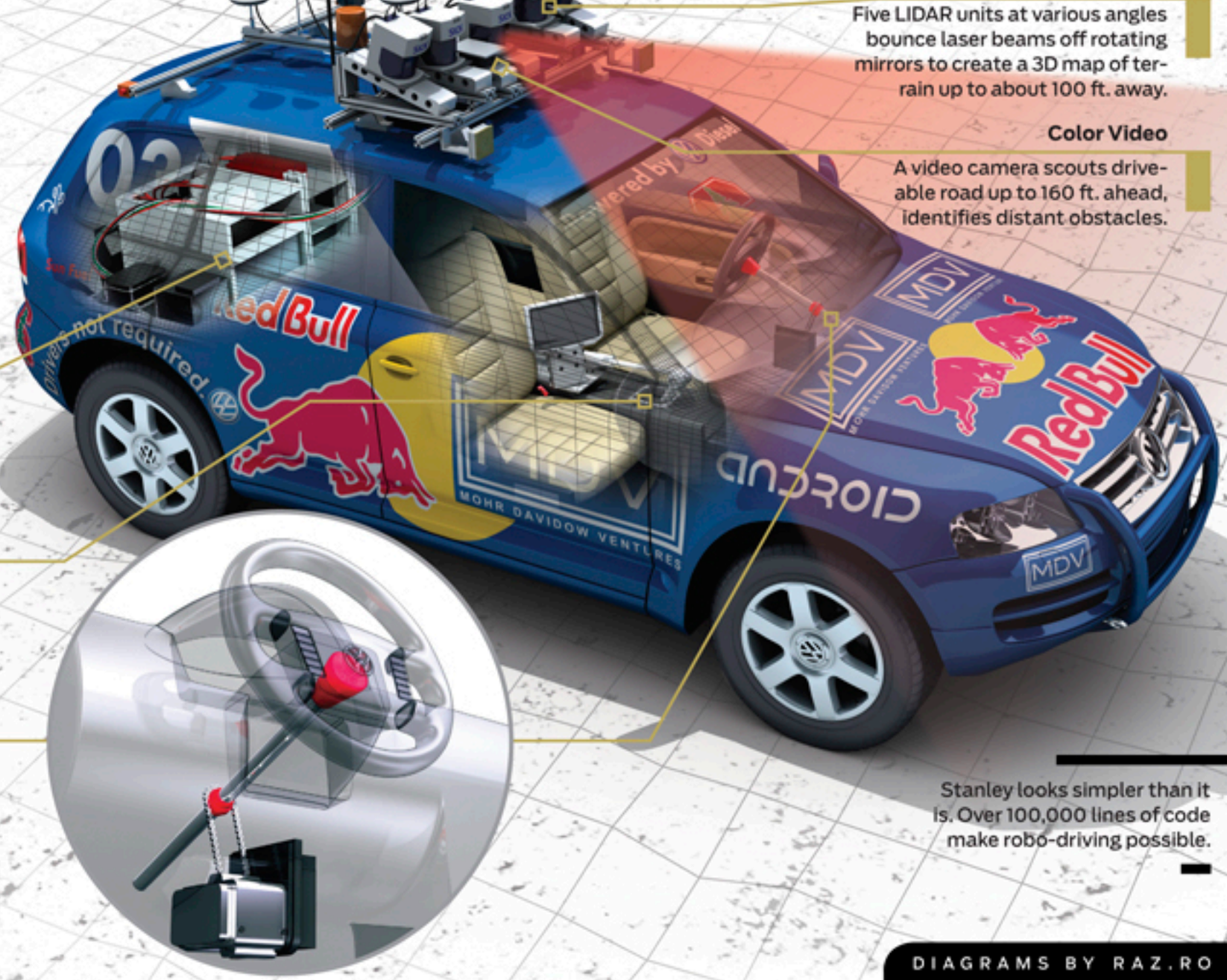
Three gyroscopes and three accelerometers mounted above the rear axle provide detailed orientation data in "6D."

Light Detection and Ranging

Five LIDAR units at various angles bounce laser beams off rotating mirrors to create a 3D map of terrain up to about 100 ft. away.

Color Video

A video camera scouts driveable road up to 160 ft. ahead, identifies distant obstacles.



Stanley looks simpler than it is. Over 100,000 lines of code make robo-driving possible.

DIAGRAMS BY RAZ.RO