Autonomous Vehicles - Past, Present, & Future
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# AUTONOMOUS VEHICLES
# PAST, PRESENT, & FUTURE

Every year students from Desert Robotics look forward to the National Research and Design Challenge. The subjects are always compelling and highly interesting. Over the years we have enjoyed learning about the exciting future of robots. There have been robots on the moon, on Mars, in agriculture, and even bionic prosthetics. This year the subject was autonomous vehicles and was introduced as follows:

"Imagine being able to jump into your car, tell it where you want to go, and then sit back and relax (or even sleep!) while your vehicle navigates to your destination. Completely autonomous private vehicles are not yet available to the public, but every year they are less a fantasy from science fiction and more a product from tomorrow's catalogs and show rooms." [11]

Autonomy is a complex yet understandable subject. The concept technology exists today, but is not available to the general public to buy. In other words, it isn't commercial - yet. You see, with technology changing so fast, you never know when something will be available. Autonomous vehicles could become a standard of transportation in as little as 5 years, or it could take as long as 30.

The future of Autonomous Cars began in 1977. The first autonomous car achieved speeds of 20 m.p.h by tracking white street markers. The evolution did not stop there and it continued well off into the future. This was the beginning of an optimistic future ahead.

In 1995 Ernst Dieter Dickmanns reengineered a Mercedes S-Class to embark on a 1600 km trip from Munich in Bavaria to Copenhagen in Denmark and back, using saccadic computer vision and transputers to react in real time. The robot achieved speeds of 175 km/h on the Autobahn. The car drove 95% of the time autonomously with regular human interventions. The car was able to execute maneuvers on real roads and pass cars, change lanes, all the normal things a human would do behind the wheel of a car. At the end of its journey the autonomous S-Class drove 158 km by itself with no human control/intervention.

The present is setting its eyes on the autonomous technology that can one day be a commodity among us. New vehicles such as Stanley, and the GM prototype "Boss" are emerging all over the place and with GM setting its sights on releasing one as soon as possible don't be surprised if in the next ten years these new breed of cars will become a common thing in a town near you.

Here are some of the autonomous vehicles we discovered in our research that we thought were particularly interesting and held promise of the future to come.

# Stanley:

[P1]

[P2]

"Stanley" the autonomous vehicle from Stanford is based on a stock Diesel-powered Touareg R5. It was modified with a reinforced bumper and full body skid plates along with many sensors, computers, and cameras. Stanley has seven Pentium M computers on board for processing which is powered by a battery-backed, electronically-controlled power system. The vehicle gets it's measurements from GPS, a 6DOF inertial measurement unit. It also has wheel speed for pose estimation. Stanley sees it's surroundings with four laser range finders, a radar system, a monocular vision system, and a stereo camera pair. The sensors acquire data at between 10 and 100 Hertz. Stanford started developing Stanley in July of 2004. Stanley came in first place on the DARPA Grand Challenge and is one of the most successful autonomous vehicles. [1]

# Robby, the Autonomous Rover

Robby was built in 1990 and was the first autonomous vehicle to drive through rough terrain and navigate around obstacles. This rover found its way around 100 meters of rough terrain in 4 hours. The rover was equipped with many onboard cameras and sensors. To reach the end of the 100 meters Robby used stereo vision and path finding.

Robby was a prototype for future autonomous rovers by NASA. Robby is 13 feet long, five feet wide, and about 6.5 feet tall. Robby also has six wheels which makes it easier to traverse rough terrain. Robby was 2500 pounds and has two onboard computers. Not only that but it also has a robotic arm to pick up surrounding objects. [2]

[P3]

**Robby, Planetary Rover Milestone, 1990**

Robby, a Mars Rover prototype and testbed

You can watch a video of Robby in action at this website: http://www-robotics.jpl.nasa.gov/videos/allVideo.cfm?Video=87

# Zoe - Searching For Life on Other Worlds

Zoe's LIfe Detetion Techology

Zoe the Life Detecting Robot

Zoe the autonomous robot is searching the Atacama desert, one of the driest regions on earth for life. NASA hopes to use Zoe for other missions including sending Zoe to other planets.

Zoe was developed by Carnegie Mellon University. The robot looks for life by looking for cells that contain chlorophyll which glow when sprayed with either one of the four dyes Zoe is equipped with.

Zoe can take samples of rock and soil and can also send pictures that it has taken to scientists. [3]

# Big Dog

Big Dog is Boston Dynamics main autonomous robot. It is made for rough-terrain and can run, walk, climb, and follow soldiers all while carrying heavy loads. Big Dog has four legs that have been copied from animals. If Big Dog is pushed it will balance it self so it does not fall over. Big Dog has on-board computers and a variety of sensors. Big Dog runs at a steady 4 mph and can climb slopes up to a 35 degree angle. [4]

**BIg Dog - A Rough Terrain Robot**

Big Dog can walk in in mud, snow, water, and can carry a 340 pound load. It is 2.5 feet tall, 3 feet long, and is around 240 pounds. Big Dog has also set a world record by traveling 12.8 miles without refueling or stopping. Boston Dynamics' main goal is to make Big Dog be able to go anywhere humans can go. Big Dog is also able to recycle energy, this way it can travel farther without stopping. [4]

# Rise V3

The RiSE V3 robot was made by Boston Dynamics after creating RiSE V1 and V2. It was designed to climb up poles. The RiSE can climb at up to 22 cm per second. The RiSE uses some of the latest technology, such as brushless DC motors that increase power. So far the robot works well but can't do the job completely on it's own yet. It's main job will be to climb and work on telephone poles. In addition to all the other advancements it also is equipped with a very different leg mechanism compared to RiSE V1 and V2. [5]

Rise V3 on a Telephone Pole

## AeroBot Blimp

[P8]

[P9]

The core autonomy technologies required for an Aerobot (robot airship) are being developed by JPL. This Areobot is a blimp that is autonomous and is expected to go to solar system bodies that have an atmosphere. The primary target of Aerobot is to explore Saturn's moon Titan, but will be able to travel to many other planets in space as the technology progresses.

Aerobot's avionic system is built around a dual-stack computer system. One is dedicated to flight control and navigation. The other is only for image processing. Many field tests of the autonomous flight control system and the JPL Aerobot have been conducted at El Mirage dry lake located in the Mojave Desert. [6]

The length of the Areobot is 11 meters long. It also has 2, 3 hp fuel engines. The diameter is 2.5 and the total amount is 34 meters cubed. It has double cantenary gondola suspension. It can carry a payload of 12 kg. [6]

# How Are We Going to Get There?

## We already have a good start to make robot cars in the future.

### Already Here:

Anti Lock Brakes
Self-Parking Cars
Warning Systems
Back-Up Cameras
GPS Tracking
Navigation Systems
Zip Cars

### Just Around the Corner:

Networking Cars/Traffic
Crash Avoidance
Delivery Robots
Robotic Transit
Human Assisted Robots

### In The Future:

Robocar Highway Lanes
Intelligent Car Computers
Robot Truck Convoys
Farm Robot Machines
Robots in Mines
Full Auto Pilot Systems

# Some Examples of Technology that Could Lead to Robocars:

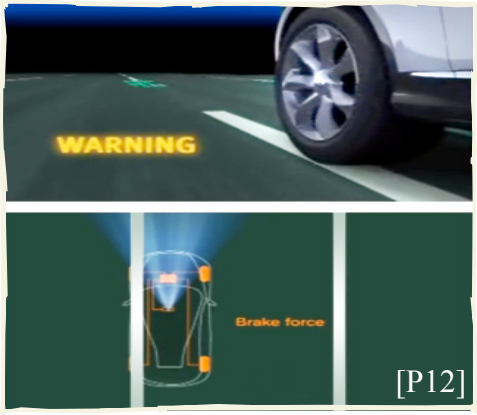
Lexus LS 460 L self parking sedan uses an advanced parking guidance system with 4 rear and 6 front sonar sensors to detect cars and a wide angle backup camera. [7]

Lexus LS 460 L

Volvo S60

The 2010 Volvo S60 has a pedestrian tracking system with full auto braking. If a person walks in front of the car the system warns the driver and will apply the brakes if he does not in time. [8]

Infinity M and EX have collision avoidance technology with a lane departure warning system, LDP. It uses a camera on the rear view mirror and warns the driver if he gets too close to the lane line and uses brakes if necessary. There is also a Around View Monitor that shows the driver an overhead view of the EX like in a car racing game. [9]




Infinity Brake Force Warning System

Travalution Traffic Management Project

Travalution is a German traffic light communication system that lets smart traffic lights communicate with special Audi cars. The computer uses the information to display the speed that will miss all the red lights. This reduces travel time and saves gasoline. [10]

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