

NAVICONTROL

Driverless Test System Steering and Pedal Robots

NaviControl is an Autonomous Driving System that replaces the human driver activities by operating the steering wheel, the pedals and the gearshift.

Due to a differential GPS receiver the system is capable to follow a pre-defined track with an accuracy of ± 5 cm, maintains the speed with a deviation of ± 0.5 km/h and reproduces a constant deceleration with an accuracy of ± 0.03 g.

A Wi-Fi connection allows the data transmission and also the RTK correction, from the Base Station to the vehicle and vice versa.

The NaviControl can be supplied with a 64 channels Daq and 2 CAN Bus reader for data logging capability.



Main Applications

Replacing the driver for reduce risk and enhance the accuracy and the repeatability of the maneuver.

- 🚗 Dynamics (fish hook, ISO lane change)
- 🚗 Durability in arduous conditions
- 🚗 Misuse and low speed collisions
- 🚗 Crash tests into the barrier (EN 1317)
- 🚗 ADAS Testing

Once the path has been created and the operator has entered the navigation parameters the GPS receiver supplies the necessary data both for track and speed control, and allows at any time to take over control from the Ground Base in order to change the track or stop the vehicle in a safe place.

Features

Path generation while driving or by using geometrical segments.

Existing path can be changed to generate a new test track to perform a pre-defined maneuver at a specific point on the track.

Autonomous or manual speed control, it allows to associate a speed profile to a specific section of the track (deceleration control with accelerometer feedback or step/ramp force or position inputs).

Quickly installation with manual or automatic gear shift.

The vehicle can be driven by a remote joystick unit with the system completely installed .

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Functional description

The steering robot has a self-centering gripper to turn the steering wheel, an harmonic drive reduction gearing and an anti-rotational mechanism. It can be mounted at the windshield, at the roof or onto the driver seat. In addition the driving robot has electrical actuators to operate the pedals and the gearshift and allows the execution of road test on pre-defined tracks or manual driving with the remote joystick unit.

Pedal actuators can be quickly fixed onto the driver seat, as the same for the gearshift, where customized fixture can be required.

An emergency pneumatic actuator is insert into the brake robot for safety operation in case of power lost. The emergency actuator is supply with a fully independent micro air compressor.

The **Control Unit** allows to control the steering robot for open loop maneuvers with a wide range of steering inputs, and closed loop maneuvers using a differential GPS.

The pedals and gearshift robot can be added to the base version according to the customer needed.

An on board camera allows to drive the vehicle first at low speed from the BaseStation and then to monitoring the proving ground safety conditions to stop quickly the vehicle in an emergency.

Moreove, even though the steering and the pedals robot are mounted the operator, seating on the passenger seat, can control the vehicle by the Remote Joystick Unit.

The system is able to drive a wide range of vehicles, reacting automatically to over-steer or under-steer, at high levels of lateral g in all-weather condition, 24 hours a day.

Many safety features are designed to avoid a vehicle loss control, the Wi-Fi connection, the GPS signal the power quality are continuously monitored and in emergency case the vehicle can be stopped automatically or manually.

Software

The NaviControl Software, running under Windows 7/Vista/XP, allows to create a track with acceleration and deceleration profiles, and to insert pre-defined maneuvers at a specific point of the track.

From the Base Station all the navigation data and the system diagnostic are monitored. The navigation data (position, speed and heading) are logged into the base Station, additional 64 analogue input channels, 8 digital I/O and 256 x 2 CAN bus channels can be acquired and saved into the Control Unit.

The NaviEmbed Software, installed in the Control Unit, perform a real-time corrections to the vehicle's steering, and the path is followed with an accuracy less than 5 cm on the straight and about 20 cm in curve (depending on the vehicle dynamic behaviors). The speed profile are followed using feedback from the acceleration value acquired from the IMU device. The brake robot can also be driven in displacement or in force control.

Specific software modules were been created to meet international regulations or to develop customer requirements.



Above: NaviControl Control Unit in the manual gearshift configuration (robots connector side).



Above: NaviControl Control Unit in the manual gearshift configuration (Daq and CAN Bus connector side).

Control Unit

Fixed onto the passenger seat the Control Unit controls the steering robot and, if available, the pedals and gearshift robots.

By using the Remote Joystick Unit the operator can easy make the system setup, drive the vehicle to the track and verify the system status.

To the Control Unit are also connected to the GPS antenna, the IMU (Inertial Measurement Unit), the on-board camera and the Wi-Fi Access Point.

The Control Unit is supply in one or two ABS rugged bags, easily and quickly transferable from one vehicle to another.

For durability and misuse testing the Control Unit is supplied with an internal vibration resistant aluminum frame.

Bottom: on the left the Remote Joystick Unit, on the right the GPS antenna and the IMU fixed on the windshield.



General Technical Data

Path following accuracy	± 5 cm
Speed control accuracy	± 0,5 km/h
Constant deceleration accuracy	± 0.03 g
Power supply (vehicle battery)	12 VDC
Wi-Fi range (standard version)	1 km
Typical installation time (automatic gearshift)	< 1 h
Operating temperature (°C)	-5 / +55
Shock resistance (per axis)	100 g

Base Station

Based on a laptop where is running the NaviControl Software to display the telemetry data and the system status. The main navigation parameters monitored and logged are: position, speed, track error, roll, pitch and yaw rate, accelerations (X,Y,Z), steering angle and torque, actuators displacement and force.

A second laptop can be used for display the picture of the on-board camera (two cameras can be connected on the same time).

All the electronic devices are continuously verified and any problem can be detected and it allows to stop the vehicle. From the Base Station the vehicle can be driven at low speed. An emergency button allows to stop quickly the vehicle in an emergency.

The Base Station is normally located closely to the differential GPS receiver and the Wi-Fi Access Point, all the components can be supplied with 12 VDC or with an AC adaptor for long duration vehicle testing.

Bottom: on the left the Ground Base with GPS antenna and Wi-Fi Access Point, on the right the NaviControl Software installed on a Laptop (Base Station).



Steering Robot System

The Steering Robot allows a wide range of steering inputs for all customer requirements.

Available in several version with different torque and speed combination, from the lightweights version for crash test to the 150 Nm for truck homologation testing.

The Steering Robot can supplied with or without differential GPS receiver. Useable with an external manual trigger input or synchronized with vehicle position

The self-centering gripper, used in all models, avoids to remove the steering wheel reducing the installation time at 20 minutes.

All the models can be fixed on the windshield, on the driver seat or on the roof, depending on the shock test level.

Driving Robot - DR66H50

Max torque	18 Nm
Max speed	60 rpm
Weight	7 kg
Motor type	stepper

The DR 66H50 can be supplied in unlocked version to fully comply the EN 1317 (max residual torque < 0.1 Nm).

Driving Robot - DR98P10

Continuous torque	18 Nm
Max speed	180 rpm
Weight	12 kg
Motor type	stepper

For durability and misuse test, designed to reproduce the human capability in uncomfortable conditions.

Driving Robot - DR210B30

Max torque @ 200 RPM	97 Nm
Max speed @ 45 Nm	300 rpm
Weight	15 kg
Motor type	brushless

For NHTSA and Euro NCAP steering inputs requirements.

Driving Robot - DR210B50

Max torque @ 75 rpm	224 Nm
Max speed @ 118 Nm	200 rpm
Weight	19.5 kg
Motor type	brushless

Brake, Accelerator and Clutch Robots

Any NaviControl system can be upgraded with brake and accelerator robots. To drive vehicle with manual shift gear also clutch and gear change robots are available.

Designed to be fixed on the driver seat, the brake and accelerator robot can be quickly installed.

The brake pedal is normally used to apply step or ramped force or displacement input. It can also be used to control vehicle deceleration when the IMU device or an external accelerometer is used for feedback.

For driverless test brake, accelerator and steering robot are used to synchronized the path with a specific speed profile.

A very accurate control of the accelerator robot allows to maintains the speed with a deviation of ± 0.5 km/h. For the crash test a special algorithmic was been developed to reach the target speed at the minimum distance as possible.

When manual shift gear is present the clutch robot can be fixed on the driver seat like to the other actuators, instead the gear change robots is fixed to the passenger seat.

Brake Robots – BR66P8

Max force	800 Nm
Max speed	400 mm/s
Available stroke	50 ÷ 150 mm
Motor type	stepper

All the brake robot models can be supplied with an integrated pneumatic emergency actuator (EB option).

Accelerator and Clutch Robots – AR46P4

Max force	450 Nm
Max speed	250 mm/s
Weight	50 ÷ 150 mm
Motor type	stepper

For safety reason the accelerator robot can be supplied with a pre-loaded gas spring to recover the accelerator position in case of emergency (RS option).

Gearchange Robots – AR46P25

Max force	720 Nm
Max speed	150 mm/s
Available stroke	50 ÷ 400 mm
Motor type	stepper

The gear change robots were been designed for cars and truck with motion control in polar or Cartesian coordinates.

Software Modules

The NaviControl Software is available in different modules as described below.

The **Path Following Software Module**, designed for standard path generation using recorded position and base editing functionality: straight-line and constant radius circle. Single map management (open and closed loop) and the standard speed control (navigation/manual speed, throttle on/off and full brake).

The **Misuse and Crash Test Module**, adds to the previous functionality the multi map management (open and closed loop) and the advanced speed control (navigation and target speed, step or ramped brake force, triggering IN/OUT functions, crash area sector).

The **Dynamic Software Module**, adds to the Path Following Module the multi map management and the advanced speed control with constant deceleration and advanced heading capability (over/under steering control).

This module is request for close loop maneuvers like ISO lane-change, steering feel test (variable radius circle) and slalom, but also for open loop driverless maneuvers like sine with dwell and fish hook.

The most complete **Durability Software Module** offer the full speed control (speed profile and acceleration control) with multiple vehicle interaction.

CanBus reading for automatic map changing and gearshift synchronized control are also available.

Specific Light Software Modules can be supplied for steering and brake robot control where the path following capability are not request.

