



AUTONOMOUSTUFF SPEED AND STEERING CONTROL QUICK-START GUIDE

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The purpose of this guide is to provide basic information on how to get started with AutonomouStuff's (AS) Speed and Steering Controller (SSC). For questions regarding the content of this guide, or questions regarding SSC, please contact the world-class support staff at AutonomouStuff.

Overview

The Speed and Steering Control software package is a collection of ROS software packages that provide customers with a simple interface to emulate typical human driving behavior. The software only requires desired vehicle curvature, max curvature, desired speed, acceleration limit, and deceleration as input parameters.

This software package reads in the desired control parameters and vehicle feedback and filters it through specially tuned control algorithms to provide all the required messages for the drive by-wire control system.

SSC saves months of building a unique speed and steering controller by providing a simple interface that is already tuned to emulate human like driving behavior.

How to install

Please contact the AS Support Team for assistance with full installation of SSC. A key pair for the repository link and a license file is required. After acquiring license and repository access, perform the following steps:

Add AS Ubuntu Repositories :

1. `sudo apt update && sudo apt install apt-transport-https`
2. `sudo sh -c 'echo "deb [trusted=yes] https://s3.amazonaws.com/autonomoustuff-repo/ $(lsb_release -sc) main" > /etc/apt/sources.list.d/autonomoustuff-public.list'`
3. `sudo apt update`
4. Once you've updated apt, you can install any of the ROS binary drivers with:
 - a) `sudo apt install ros-$ROS_DISTRO-<product_name>`
5. Install the AS Common Library, use `sudo apt install libas-common`.

Add SSC Repository:

1. `sudo apt update && sudo apt install apt-transport-s3`
2. `sudo sh -c 'echo "AccessKeyId = <access-key>" > /etc/apt/s3auth.conf'`
 - a) Replace <access-key> with your Amazon S3 access key.



3. `sudo sh -c 'echo "SecretAccessKey = <secret-key>" >> /etc/apt/s3auth.conf'`
 - a) Replace <secret-key> with your Amazon S3 secret key.
4. `sudo sh -c 'echo "Token = "" >> /etc/apt/s3auth.conf'`
5. `sudo sh -c 'echo "deb [trusted=yes] s3://autonomoustuff-ssc.s3.amazonaws.com/ $(lsb_release -sc) main" > /etc/apt/sources.list.d/autonomoustuff-ssc.list'`
6. `sudo sh -c 'echo "yaml https://s3.amazonaws.com/autonomoustuff-repo/autonomoustuff-public-'$ROS_DISTRO'.yaml" > /etc/ros/rosdep/sources.list.d/40-autonomoustuff-public-'$ROS_DISTRO'.list'`
7. `rosdep update`
8. `sudo apt update && sudo apt install ros-$ROS_DISTRO-speed-model ros-$ROS_DISTRO-steering-model`
 - a) For vehicle-specific controllers, install packages such as:
 1. `ros-$ROS_DISTRO-ds-veh-controller`
 2. `ros-$ROS_DISTRO-pacmod-veh-controller`
 3. `ros-$ROS_DISTRO-pacmod3-veh-controller`

Note: If using a Lexus install the pacmod3 vehicle controller

Launch

Each of the `ros_vehicle` packages contain its own separate launch file. However to demonstrate the immediate capabilities of SSC, download and build the joystick_vehicle_test repo available at

https://github.com/astuff/joystick_vehicle_test

Note the following launch files for both the SSC packages and the Vehicle Joystick Test package.
Vehicle Joystick Test

- `vehicle_controller_joystick_test.launch`
- `ssc_joystick_sim.launch`

Speed and Steering Control

- `ds_veh_controller.launch`
- `pacmod3_veh_controller.launch`
- `pacmod_veh_controller.launch`
- `speed_model.launch`
- `steering_model.launch`

Speed and Steering Control Launch



To launch the full Speed and Steering package, the `speed_model`, `steering_model`, and at least one of the `veh_controllers` must be launched.

Speed and Steering Control JSON configuration

The parameters in the JSON configuration files allow a user to “tune” or adjust the SSC software. These parameters affect the various gains and factors within the control algorithms.

All default JSON configuration files are located in the core folders under the main package folder. The following section are notes on making adjustments to the vehicle response –these are just a summary, for a full description of the JSON configuration parameters see the User Manual.

Joystick Vehicle Test Application

Parameter	Default Value	Description
<code>speed_step</code>	1.0	How much the speed should increase or decrease with each button press, in mph .
<code>speed_max</code>	15.0	The maximum speed that can be commanded, in mph .
<code>acceleration_limit</code>	2.0	The acceleration limit passed to the speed module, in m/s²
<code>deceleration_limit</code>	2.5	The deceleration limit passed to the speed module, in m/s²

Steer Model

Parameter	Default Value	Description
<code>full_left_wheel</code>	8.72664626	Steering wheel angle at full left, in radians.
<code>full_left_tire</code>	0.62333188	The average angle between the front tires when the steering wheel is at full left, in radians.
<code>full_right_wheel</code>	8.72664626	Steering wheel angle at full right, in radians.
<code>full_right_tire</code>	0.62333188	The average angle between the front tires when the steering wheel is at full right, in radians.
<code>wheel_base</code>	2.84988	The vehicle wheel base in meters. Used to calculate the measured curvature by the following math: $\text{measured curvature} = \tan(\text{tire}) / \text{wheel_base}$



max_steering_wheel_rotation_rate	6.28319	Maximum rotational rate of the steering wheel in rad/seconds. 6.28 rad/s is one full revolution of the steering wheel per second
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Speed Model

min_throttle	minimum throttle output value (0.0 to 1.0 percent)
initial_throttle	value at which throttle begins to have an effect (0.0 to 1.0 percent)
max_throttle	maximum throttle output value (0.0 to 1.0 percent)
min_brake	minimum brake output value (0.0 to 1.0 percent)
initial_brake	value at which brakes begin to have an effect (0.0 to 1.0 percent)
max_brake	maximum brake output value (0.0 to 1.0)
coast_decel	Nominal deceleration at highway speeds when both throttle and brake commands are zero (m/sec ²)
minimum_desired_speed	Lower limit on desired speed, anything below this is considered 0 (m/sec). Below this speed the controller is no longer accurate.
minimum_measureable_speed	Vehicle speed below which the wheel speed sensors drop out (m/sec)

***Note: The Speed Model contains all the gain parameters, it is beyond the scope of this quick-start guide.

Vehicle Controller – PACMod3

- publish_interval: The publish interval of the enable and disable commands, in seconds.
- publish_state_interval: The publish interval of the module's state, in seconds.
- command_timeout: The interval between speed and steering messages after which a timeout is triggered, in seconds.
- report_timeout: The interval between drive by wire report messages after which a timeout is triggered, in seconds.
- ignore_override_time: The ignore driver override flags for throttle, brake, and steering are set for this long when the speed or steering modes are enabled, in seconds. This allows the driver to go to auto while on the gas or brake pedals as long as they release them shortly after.
- re_enable_time: The time after a driver override before the module attempts to clear the condition, in seconds.

```
"publish_interval": 0.05,
```



```
"publish_state_interval": 0.5,  
"command_timeout": 0.5,  
"report_timeout": 0.5,  
"ignore_override_time": 3.0,  
"re_enable_time": 2.0
```

Vehicle Interface -PACMod3

- tire_radius: Radius of tires (m)
- velocity_filter_const: Filter factor for vehicle velocity (0.0 to 1.0)
- accel_filter_const: Filter factor for vehicle acceleration (0.0 to 1.0)

```
"negate_steering": 0,  
"speed_scale": 1.0,  
"velocity_filter_const": 0.9,  
"accel_filter_const": 0.95,  
"use_vehicle_speed_sign": 1.0,  
"tire_radius": 0.29
```

Joystick Interface (Joystick Vehicle Test Application)

An application for converting user's joystick commands into gear, steering, speed, and turn signal commands to pass to the AutonomouStuff vehicle control software. Use the launch file provided to start this module, the vehicle control software modules, and the drive by-wire module. It is recommended you use the `--screen` option when launching so that the feedback provided by the module can be seen.

Once the software is running, push the engage button on the joystick. ENGAGED will be output to the screen. The desired speed defaults to zero miles per hour when joystick is engaged, so the software will automatically engage the brakes.

The drive button can now be pressed to place the gear in drive, since the desired speed is still zero the brakes will still be applied. Pressing the speed up and down buttons will increment and decrement by the configured step amount, limiting the speed between zero and the maximum speed set. Any time a speed button is pressed the new desired speed will be output to the screen. To bring the vehicle to a stop, step the speed back down to zero, and the control software will gently apply the brakes to bring the vehicle to a stop. There is no way through this software to directly apply the brakes with the joystick, but the brake pedal can always be applied by the driver to override the joystick control mode.

The steering gain and exponent convert the steering joystick to a desired curvature which is passed down to the steering model. The gain defines the maximum curvature, so the default of 0.12 1/meters allows for a minimum turning radius of about 8 meters. The exponent controls the shape of the response:

- A number closer to 2 or above will mean small joystick movements will translate to very small desired curvatures and therefore steering wheel angles.
- A number closer to 1 will mean the curvature varies more linearly across the full joystick range.



The curvature command can also be changed by pressing the left and right steering buttons. The updated curvature will be output to the screen. The steering joystick will override the value set with the buttons.

The left and right turn signals can also be controlled with the buttons. The turn signals will stay on as long as the button is pressed.

Pressing either the disengage button on the joystick or both the cruise control set/inc and increase gap buttons on the steering wheel will give control back to the driver (as will any drive override on the brakes, throttle, or steering wheel). DISENGAGE will be sent to the screen, or a message with information if there was an override.

Note: Reverse gear is not currently supported. The vehicle controller does not support reverse itself, mainly because the speed model has not been adequately tested yet in reverse.

Note: It is intended that this application be used as an example of how to interface to the vehicle control software and can be used as a starting point for the development of higher-level autonomy features.

ROSTOPICS

Note: Setting the Mode to 1 will enable the system.