

## ABS

ABS is an electronic system of a car intended to help a driver in extra braking situation.

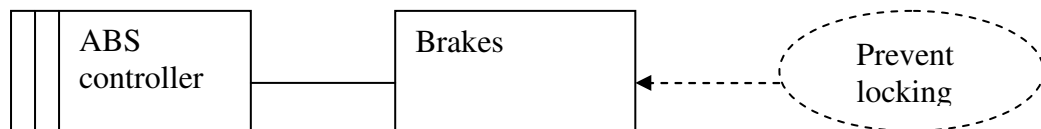
Requirements:

- When the car is driving, and the driver doesn't push braking pedal, ABS should do nothing, just monitoring states of each wheel.
- In situation when one or more wheels lock while the driver is trying to slow down the speed by pedaling the brake pedal, ABS should recognize this situation and decrease braking force on locked wheels to unlock them.
- ABS should work (i.e. monitor wheels and control braking force when needed) when speed of the vehicle is greater than 10km/h. If the speed of the vehicle is less than 10km/h, then ABS should just monitor the sensors.
- ABS is on all the time battery is in position.

Description:

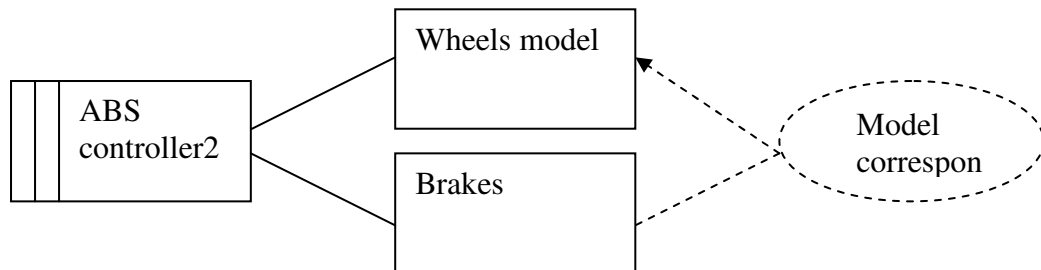
- Every wheel has its own sensor that sends a signal when wheel has rotated for 1/200 of one turn.
- Braking pedal applies main braking cylinder. The pressure in cylinder increases and it's transmitted by brake conduits to each wheel where brake cylinders are. In every brake conduit there is a valve that can decrease pressure in brake cylinder on certain wheel.

A Simple Behavior problem frame can be applied to this problem:



C1!ABS, C2!Br, C3!PL

Every time your ABS should know the speed and acceleration of each speed. So to simplify the problem we can distinguish a sub problem: a Simple Information problem:



This model domain answers on questions about states of each wheel, their speed and acceleration.

Let's look at our main problem and try to define phenomenas.

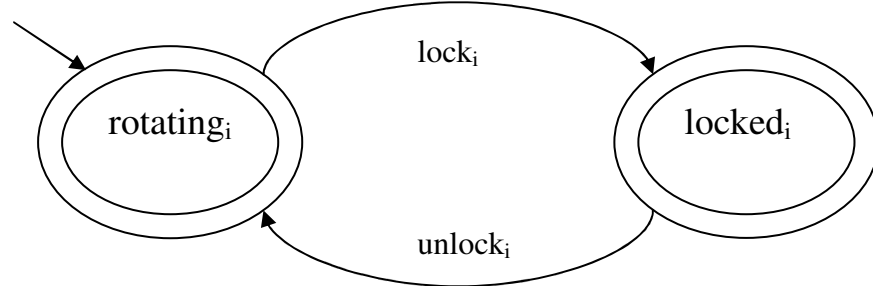
Events first:

- C1:  $\text{lockvalve}_i(e)$  – event: in event  $e$  a signal comes to valve  $i$  and valve decrease pressure a 1/10 times;  
 $\text{unlockvalve}_i(e)$  – event: in event  $e$  a signal comes to valve  $i$  and valve increase pressure a 1/10 times;
- C2:  $\text{sensorsignal}_i(e)$  – event: in event  $e$  a signal comes to a controller from wheel  $i$  and indicates that concrete wheel has turned 1/200 times;
- C3:  $\text{speedgreater10}(e)$  – event: in event  $e$  speed of the vehicle becomes greater than 10km/h;

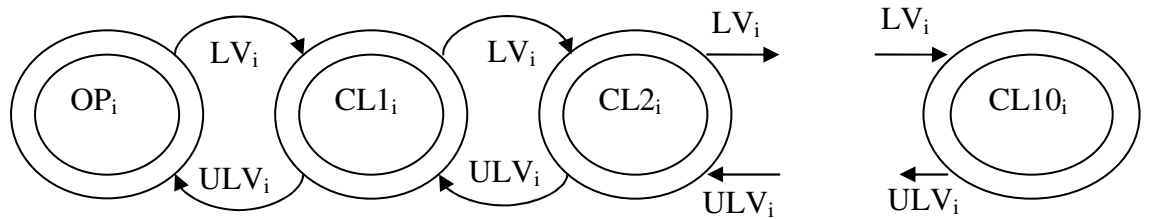
$\text{speedless10}(e)$  – event: in event  $e$  speed of the vehicle becomes less than 10km/h;  
 $\text{lock}_i(e)$  – event: in event  $e$  wheel  $i$  locks;  
 $\text{unlock}_i(e)$  – event: in event  $e$  wheel  $i$  unlocks.

States are shown on state diagrams below:

IND1)



DEF1)



Some comments:  $\text{OP}_i$  –  $\text{open}_i$  – state: state when valve  $i$  is open;  $\text{CL1}$ ,  $\text{CL2}$ , ...  $\text{CL10}$  –  $\text{closed}_i1$ ,  $\text{closed}_i2$ , ...,  $\text{closed}_i10$  – state: state when valve  $i$  is closed 1/10 times, 2/10 times, ... , 10/10 times;  $\text{LV}_i$  – event  $\text{lockvalve}_i(e)$ ;  $\text{ULV}_i$  – event  $\text{unlockvalve}_i(e)$ .

DEF2)

