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Course: Grundlæggende Indlejrede Systemer (GiS)
Modul 3, Regulering af dynamiske systemer
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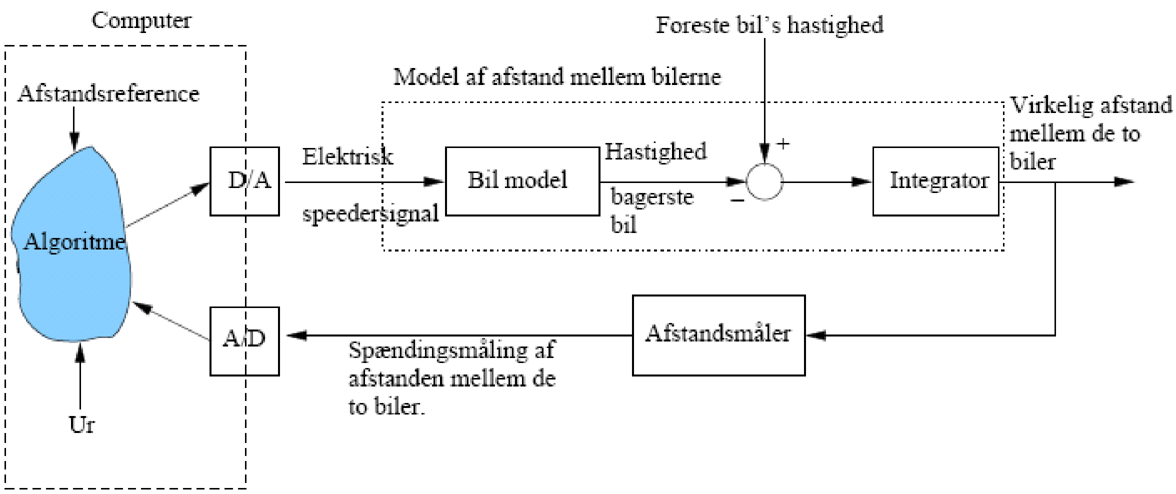
1. Introduction



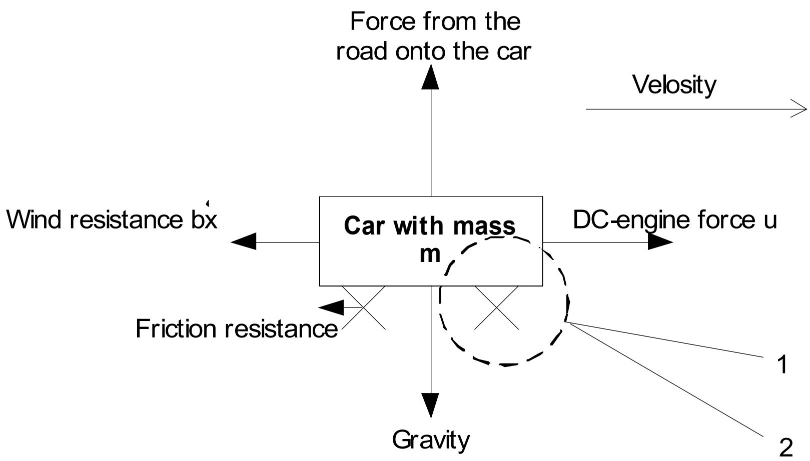
1.1. Objectives

The objectives of the project are to:

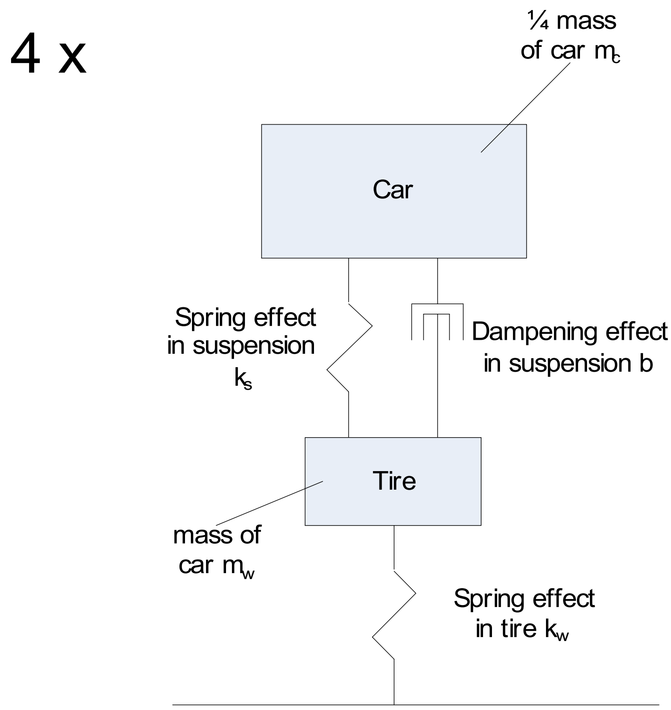
- Design the SW framework and select a subset of the POSIX API to be used in the SW framework.
- Apply real-time capabilities to the OS
- Verify and test the real-time performance of the OS run on the target HW.

2. Problem domain

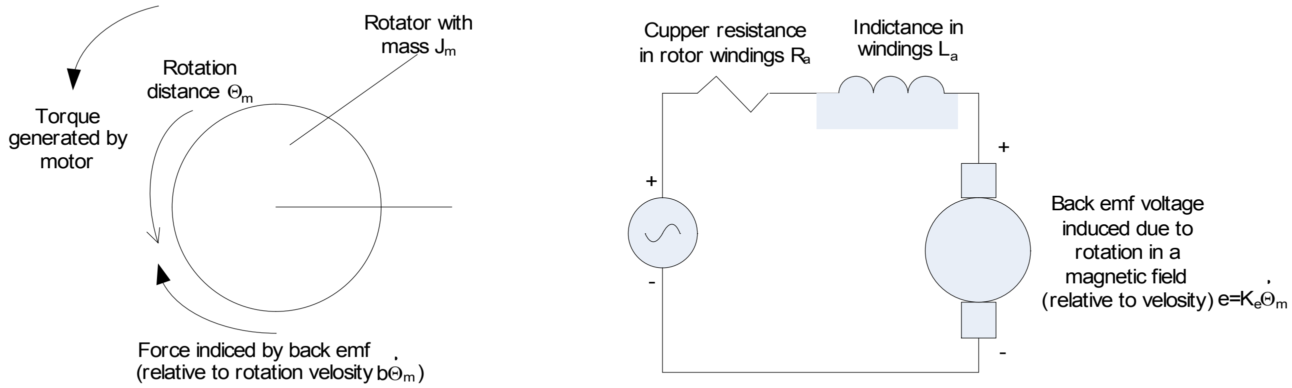
Problem definition



Overall frit-legeme



Detailed frit-legeme 1



Detailed frit-legeme 2

NB: Is rotator mass including the wheel-mass??? - Is the rotation distance the rotation of the wheel? It might be as the wheel is directly attached to the shaft, so it might be considered part of the rotator.

In the above is only shown the overall forces affecting the system. Many, many has been ignored because they are negliable. A complete list will not be supplied, as it is alnmost always possible to come up with some that has not been considered. To give a few examples may be mentioned

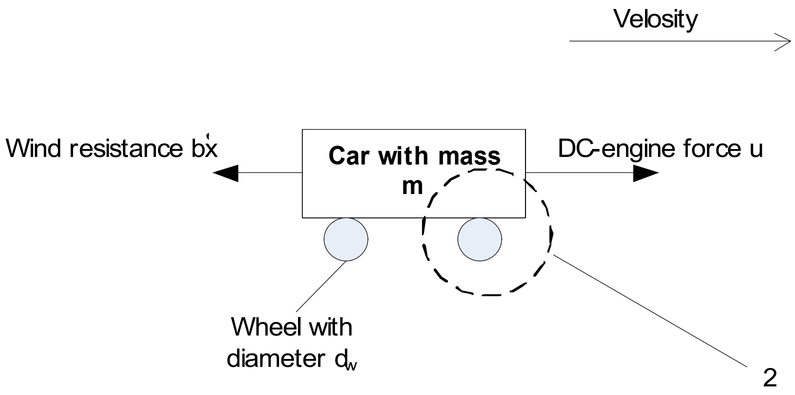
- The capacitance generated between the windings in the endian – considered to have a neglisible effect compared to the inductance and resistance.
- The initial friction resistance, which is non-linear and lager than the friction resistance lim car velosity -> 0.
- The temperature dependency of the tires spring effect.
- The loss in the transfer of torque from the engine shaft to the wheels.
- And so on and so on.

And this does not even include the asumptions made in the assignment (ignoring hills and changes in the wind, which would make the wind resistance non-linear).

In order to further simplify the model we will asumpe the frictiongenerated between the tires and the road is 0 and that the friction needed to generate forward motion from torque is infinite – perfect tires.

Finally, since there is no changes in the road (no hills, no bumps) and we ignore the breaking and accileration effect on the suspension (since the car has no breaks, we can simply asume that it has four-wheel-drive, and then the acceleration and breaking should be evenly distributed), we can ignore the effect of the tires and suspension, making the model much simpler.

As the gravity and force from the road onto the car is always even (no bump, no hills, no upwards or downwards push from the wind) and since we do not consider the friction between the car and the road (which would be dependent on the weight), we can ignore these forces as well.



From the above we can write up a set of differential equations for the individual parts of the subsystem. We also note that as the wheels are perfect we can simply do the calculations as if the car is pulling on a single wheel situated at the center of the car.

NB: Is it relevant whether it pulls on 1 or 4 wheels, when the wheels and shafts are ideal?

NB: where do the wheel mass figure in – can it simply be thought of as part of the car's weight, or is it relevant for the torque's effect on rotation? I think the mass is simply included in the car's weight.

We have to use Newton's law (F = *m*a), which (with a little integration) relates accileration to force. We also know that any mass must have an equal amount of forces affecting it in all directions (here we only have to focus on two dimensions and only two opposite directed forces) This gives us:

x: distance traveled

$u - bx' = mx''$ (velosity – wind resistance = forward force)

which can be rewritten to

$x'' + (b/m)x' = u/m$ (remember x' = velosity)

or as a transfer function

$X(s)/U(s) = (1/m)/(s^2 + (b/m)s)$

Now the output speed of the motor (which gives the velosity of the shaft and therefore the wheel), and can be calculated as

$J_m\Theta''_m + b\Theta'_m = K_t i_a$ This is dependent on i_a, so looking at the electrical relationship we get

$L_a i'_a + R_a i_a = v_a - K_e\Theta'_m$

Laplace transforming the two equations and combining them we get

$\Theta_m(s)/V_a(s) = K_t/(s[(J_m s + b)(L_a s + R_a) + K_t K_e])$

As the indiction effect is neglisible and to further simplify the equation, the inductance effect is ignored. This allows us to combine the two equations, giving us:

$J_m\Theta''_m + (b + (K_tK_e/R_a))\Theta'_m = (K_t/R_a)v_a$

Which results in the transfer function for the engine

$\Theta_m(s)/V_a(s) = (K_t/Ra)/(J_m s^2 + (b + (K_tK_e/R_a))s)$

As the distance travelled (in rad) is Θ_m we can write up a relationship between this and the car equation, when we know the diameter of the wheel.

$x = \Theta_m/(2\pi) * \text{circumfrence} = \Theta_m/(2\pi) * (\pi d_w) = \frac{1}{2}\Theta_m d_w$

or included in the transfer function

$X(s)/V_a(s) = (d_w(K_t/Ra))/((2J_m s^2 + 2(b + (K_tK_e/R_a))s)$

Combining this with the equation for the car gives us

$(d_w(K_t/Ra))/((2J_m s^2 + 2(b + (K_tK_e/R_a))s)*Va(s) = (1/m)/(s^2 + (b/m)s)*U(s)$

What is it that we want??? - I think we might want $X(s)/V_a(s)$ but we already have that, and it is independent of the speed and weight, so it cannot be right – Maybe it is U(s)/Va(s) that is the circumfrence thinging

3. Application domain analysis

3.1. Use cases

4. Accept test

5. Conclusion

6. References
