Systemkonstruktion Z3, SSY-046

23 oktober 2008

1. **Livscykelanalysen består av följande fyra huvudmoment:**

1. Måldefinition
– Bakgrund och mål för utvärdering
2. Inventeringsanalys
– Skapa ett processträd där alla processer från råvaruutvinning till utsläpp vid deponi kartläggs, länkas och mass- och energibalans är sluten (all utsläpp och konsumtion är med)
3. Effektbedömning
– Utsläpp och konsumtion översätts till miljöeffekter. Dessa grupperas och viktas.
4. Förbättringsområden identifieras och bedöms
– Ur analysen konstateras var förbättringar kan finnas

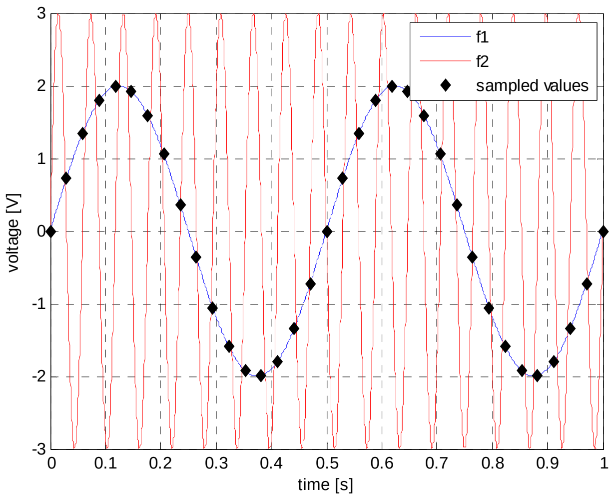
2.

- FPGA (field programmable gate array) consists of programmable logic components (blocks) and programmable interconnections. The blocks can be programmed to perform basic logic functions.
- PLC (programmable logic controller) is industrial computer which could be programmed to control processes in real time. One PLC can replace thousands relays, timers, switches, etc.
- DSP (digital signal processor) is a microprocessor specialized for digital signal processing in real time. It is usually used to solve very specific but complex mathematical problems.

3.

- Problemdefinition
- Kriterielista
- Önskemål
- Funktionsanalys
- Lösningsökning
- Kombinera dellösningar
- Val av lovande lösningar
- Utvärdering
- Produktutkast
- Livcykelanalys

4.



$f_s > 2f_{max} \rightarrow f_{max} < \frac{f_s}{2} = 17\ Hz$ (in practice $f_{max} < \frac{f_s}{4}$)

Filter all frequencies above f_{max} and then sample.

5.

a) Differential equation model is a simplified description of the reality. It is mathematical model of a real dynamical system.
b) Compact representation, simpler, cheaper, safer, no other alternative (the system does not exist).
c) Structure the system (divide into subsystems, find input outputs and internal variables) to create graph or block diagram. Then find the relationships (conservation laws, constitutive relations) to get differential equations and algebraic relationships. Then form state space model (choose state variables, form $\dot{x} = \cdots$)

6. $RMS = \sqrt{E\left\{\left(Y_j - X\right)^2\right\}}$

$argmin(RMS) = argmin(MSE)$

$Z_i = X_i - b_i \rightarrow X - Z_i \in N(0, \sigma_i)$

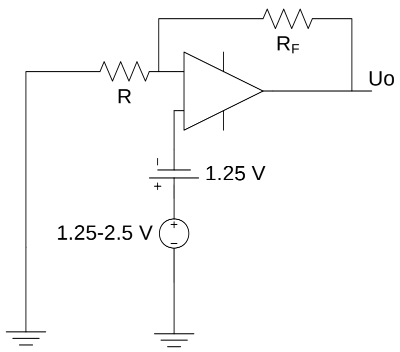
$Y = w_1X_1 + w_2X_2 + w_3 = w_1Z_1 + w_2Z_2$

$E\{X - Y\} = E\{X - w_1Z_1 - w_2Z_2\} = X - w_1X - w_2X = 0 \rightarrow\ w_1 + w_2 = 1$

$V\{Y - X\} = V\{w_1Z_1 + w_2Z_2 - X\} = V\{w_1(X - Z_1\} + (1 - w_1)(X - Z_2) = w_1^2\sigma_1^2 + (1 - w_1)^2\sigma_2^2$

$$\frac{dV\{Y-X\}}{dw_1} = 0 \rightarrow w_1 = \frac{\sigma_2^2}{\sigma_1^2+\sigma_2^2}, w_2 = \frac{\sigma_1^2}{\sigma_1^2+\sigma_2^2}, w_3 = \frac{b_1\sigma_2^2+b_2\sigma_1^2}{\sigma_1^2+\sigma_2^2}$$

7.



$$V_o = \left(1+\frac{R_F}{R}\right)(V_i - 1.25) \text{ for } V_i = 2.5, V_o = 5 \rightarrow \frac{R_F}{R} = 3$$

8.

I_d, m_d, h_d

α

F_2

F m_v

m_w, r_w, J_w

T_m, θ_m, N

r_w - wheel radius
m_w - wheel mass
J_w - wheel inertia
θ_m - motor angle
T_m - motor torque
m_v - vehicle mass
m_d - driver mass
h_d - driver height
J_d - driver inertia
α - angle of the handlebars
N - gearing

a) Specifications:
   - $r_w = 25\ cm$
   - $m_w = 5\ kg$
   - $m_d = 100\ kg$
   - $h_d = 2\ m$
   - $m_v = 40\ kg$ ...

b) Specifications, cont'd
   - $v_f = 20\ km/h$- maximum speed forward.
   - $a_f = 0.56\ m/s^2$ - maximum acceleration forward.
   - $v_b = 10\ km/h$- maximum speed backward.
   - $v_t = 5\ km/h$- maximum turning speed per motor.

- $\alpha = 5\ deg$ - max forward angle of the handlebar.

c) Measure:
- Speed of the wheels $[rad/s]$.
- Tilt forward/backward of the handlebar $[rad]$.
- "Out of balance" moment on the handlebars $[Nm]$.
- Angle left/right of the handlebars $[rad]$.

d) Sensors:
- Two tilt (or position) sensors for measuring tilting in one axis for forward/backward and left/right tilt. The forward/backward tilt sensor should have higher resolution $r < 0.002\ [rad]$ and the left/right sensor with $r < 0.02\ [rad]$.
- Gyroscopes for measuring the "out of balance" moment. They should be highly accurate.
- Tachometer for measuring the wheels speed. Resolution: $r < 1\ [rad/s]$.

e) Motor specifications:

$\dot{\theta}_m = N\ \frac{v_f}{r_w}, \ddot{\theta}_m = N\ \frac{a_f}{r_w}$

$J_w = \frac{m_w r_w^2}{2}, J_d = m_d(h_d + r_w)^2$

$T_m \approx \left(J_m + J_{gear} + \frac{1}{N^2} 2J_w\right)\frac{a_f}{r_w} N + \frac{1}{N} m_d g sin(\alpha) r_w$

$T_m \approx \frac{1}{N}\left(\frac{a_f}{r_w} 2J_w + m_d g sin(\alpha) r_w\right) \approx 2.2\ [Nm]$

For moving forward and backward, the vehicle compensates the torque caused by the leaned driver to keep the system in balance. For turning left and right the angle of the handlebar is used for regulating the wheels speed.

f) $100\ Hz$