Hernon - PCX30

Thursday, February 16, 2017 4:05 PM

Purpose of this document - Illustrate/detail/plan the "math" of the turret/encoder/valve relationship

1.) definitions

- two units
  - PC630:
    - 18 targets/rev.
    - 400 units/min. (2x 200) (2 exits)
    - Turret $\varnothing$ = 270 mm
  - PC530:
    - 12 targets/rev.
    - 250 targets/min (1 exit)
    - Turret $\varnothing$ = 180 mm
- Hardware
  - X20CP1301
    - Min. TK cycle of 2 ms = 2000 μs
- encoder
  - SSI via X2X
  - 12 bit absolute
- software/triggering
  - Need to determine "uncertainty" in timing due to TK cycle time, Bus latency, etc.

$D = [180, 270]$ mm

$T_{cycle} = 2000\ \mu s$

$N_{encoder} = 12$ bits/rev. = 4096 counts/rev.

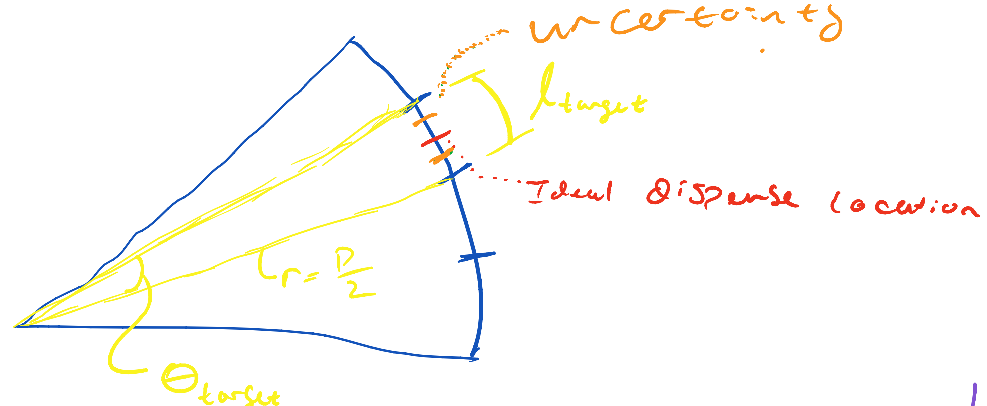
$N_{targets} = [12, 18]$ targets = [20 30] deg ← No De[illegible]

$N_{targets} = [12, 18]$ $\frac{targets}{rev} = [20, 30]$ $\frac{deg}{target}$

$V_{turret} = [250, 400]$ $\frac{targets}{minute} = \boxed{[4\frac{1}{6}, 6\frac{2}{3}]}$ $\frac{targets}{s}$

No Decimals
(keep as mixed #)

* what is our uncertainty, repeatability



Law of differentials

* In continuous system

$$\partial y = \frac{\partial y}{\partial x_1} dx_1 + \dots + \frac{\partial y}{\partial x_n} dx_n$$

⇒ assume discrete, linear system

$$\Delta y = \frac{dy}{dx_1} \Delta x_1 + \dots + \frac{dy}{dx_n} \Delta x_n$$

where Δx_n is uncertainty in each factor

⇒ If we are triggering dispense every θ_{target} degrees, we have two equations that must hold true →

$\theta_n \geq \theta_{target}$, $\theta_{n-1} < \theta_{target}$ (θ_n = dial position, current cycle

θ_n = target, $\theta_{n-1} < \theta_{target}$ (θ_n = dial position, current cycle
θ_{n-1} = " " , last cycle)

$$\Delta\theta = (\theta_n - \theta_{n-1}) = \text{differential dial movement between cycles [deg.]}$$

$$= \frac{V_{turret}\left[\frac{\cancel{targets}}{\cancel{s}}\right] \cdot l_{target}\left[\frac{\cancel{mm}}{\cancel{target}}\right]}{F_{cycle}\left[\frac{cycles}{\cancel{s}}\right] \cdot \frac{\pi D\ [\cancel{mm}]}{360\ [deg]}} =$$

$$\Delta\theta = 360 \frac{V_{turret} \cdot l_{target}}{\pi \cdot D \cdot F_{cycle}} \left[\frac{degrees}{cycle}\right]$$

$$= \frac{V_{turret}\left[\frac{\cancel{targets}}{\cancel{s}}\right] \cdot l_{target}\left[\frac{mm}{\cancel{target}}\right]}{F_{cycle}\left[\frac{cycles}{s}\right]}$$

$$= \frac{V_{turret} \cdot l_{target}}{F_{cycle}} \left[\frac{mm}{cyc}\right]$$

uncertainty due to time discretization

$$l_{target} = \frac{\Delta\theta \cdot \pi \cdot D \cdot F_{cycle}}{360 \cdot V_{turret}}$$

$$\Delta l_{target} = \cancel{\frac{dl}{d\Delta\theta}(\Delta\Delta\theta)} + \frac{dl}{dV_{turret}}(\Delta V_{turret})$$

BC $\Delta\Delta\theta = 0$ unless accelerating

$$err = \sum \sqrt{X_1^2 + \ldots + X_n^2}$$

$\Rightarrow F_{cycle}$ ... uncertainty due to

$$= \frac{\Delta\Theta \pi D F_{cycle}}{(360\, V_{target})^2} \Delta V_{target}$$

uncertainty due to encoder (position) discretization

$$l_{target} = \frac{\pi D \left[\frac{mm}{rev}\right]}{N_{targets}\left[\frac{targets}{rev}\right]}$$

≈ 6 encoder counts/mm

$\approx .3 \frac{mm}{cycle}$

≈ 0.5 mm repeatability