Backstepping reference tracking

Example:

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|  | Subs |  |
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By choosing,

And

We need to find and in terms of

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| Matlab code for symbolic manipulations |
| clear all,close all,clc;  %%  syms t real  syms x1(t) x2(t) x3(t) u(t)  syms r(t) r\_dot(t) r\_dotdot(t) r\_dotdotdot(t) real  %%  syms phi1 phi2 real  syms z2(t) z3(t) real  x1dot=(x1)^2+x2  x2dot=x3  x3dot=u  phi1=[r\_dot-(x1^2)]+[r-x1]  phi1\_dot=diff(phi1,t)  phi1\_dot=subs(phi1\_dot,diff(r(t), t),r\_dot)  phi1\_dot=subs(phi1\_dot,diff(r\_dot(t), t),r\_dotdot)  phi1\_dot=subs(phi1\_dot,diff(x1(t), t),(x1)^2+x2)  phi1\_dot=expand(phi1\_dot)  %  phi2=phi1\_dot+[r-x1]-z2  phi2=subs(phi2,z2,x2-phi1)  phi2\_dot=diff(phi2,t)  phi2\_dot=subs(phi2\_dot,diff(r(t), t),r\_dot)  phi2\_dot=subs(phi2\_dot,diff(r\_dot(t), t),r\_dotdot)  phi2\_dot=subs(phi2\_dot,diff(r\_dotdot(t), t),r\_dotdotdot)  phi2\_dot=subs(phi2\_dot,diff(x1(t), t),(x1)^2+x2)  phi2\_dot=subs(phi2\_dot,diff(x2(t), t),x3)  phi2\_dot=expand(phi2\_dot)  u=-z2-z3+phi2\_dot  u=subs(u,z2,x2-phi1);  u=subs(u,z3,x3-phi2);  % u = 3\*r + 5\*r\_dot + 3\*r\_dotdot + r\_dotdotdot ...  % - 3\*x1 - 5\*x2 - 3\*x3 - 6\*x1\*x2 - 2\*x1\*x3- 5\*x1^2 ...  % - 6\*x1^3 - 2\*x2^2 - 6\*x1^4 - 8\*x1^2\*x2 |

MATLAB Simulink simulation

Diagram

Description automatically generated

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Reference tracking

Chart, line chart

Description automatically generated