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On relative positioning of vessels

Theory

Practical implementation

Reference systems

by

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Relative Positioning Applications



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Free floating vessels

- ROV following
- Loading/ offloading Platform Supply Vessels
- Shuttle tanker loading
- Accommodation vessels

Vessels connected

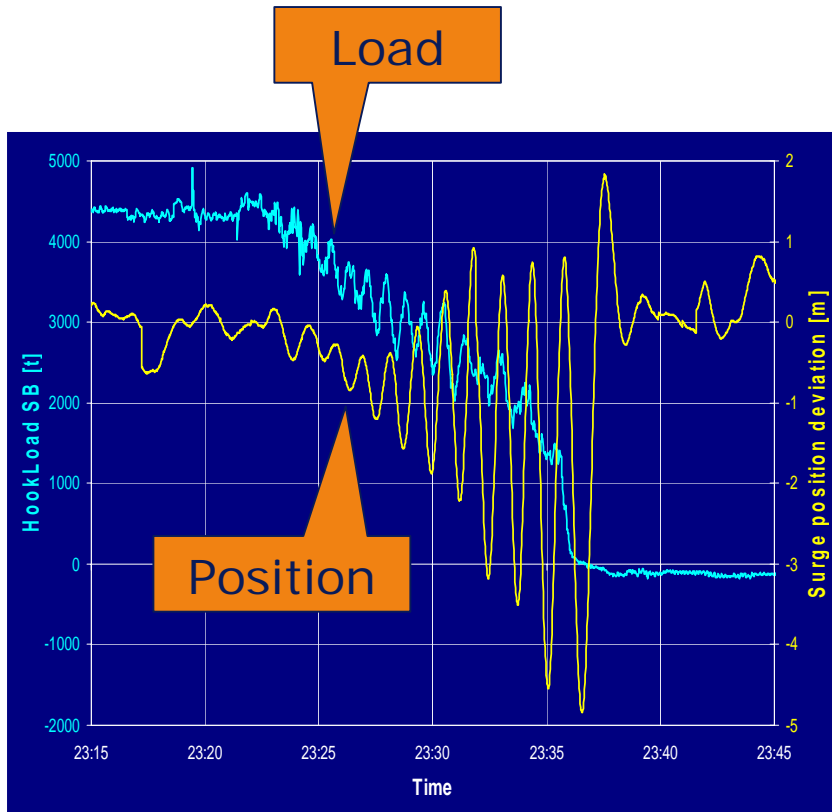
- Heavy lifting





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Heavy lifting



- Oscillations due to interconnection between bodies
 - Too large DP bandwidth
 - (In fact must be almost zero)
 - Relative position measurements do not help
 - Special severe when lifting to SPAR buoy
- Very different from free floating bodies

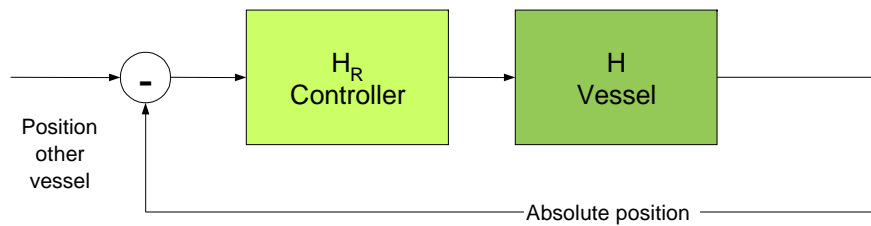
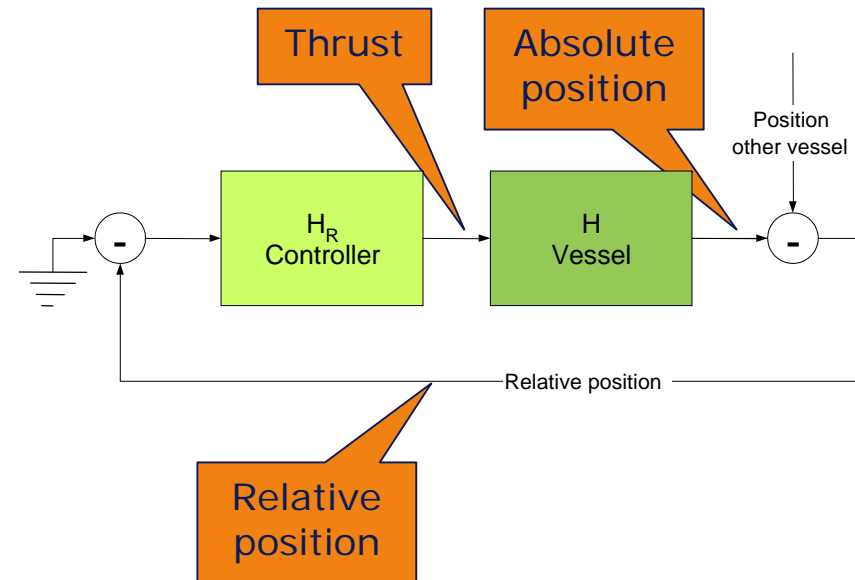
Relative Positioning Control theory aspect



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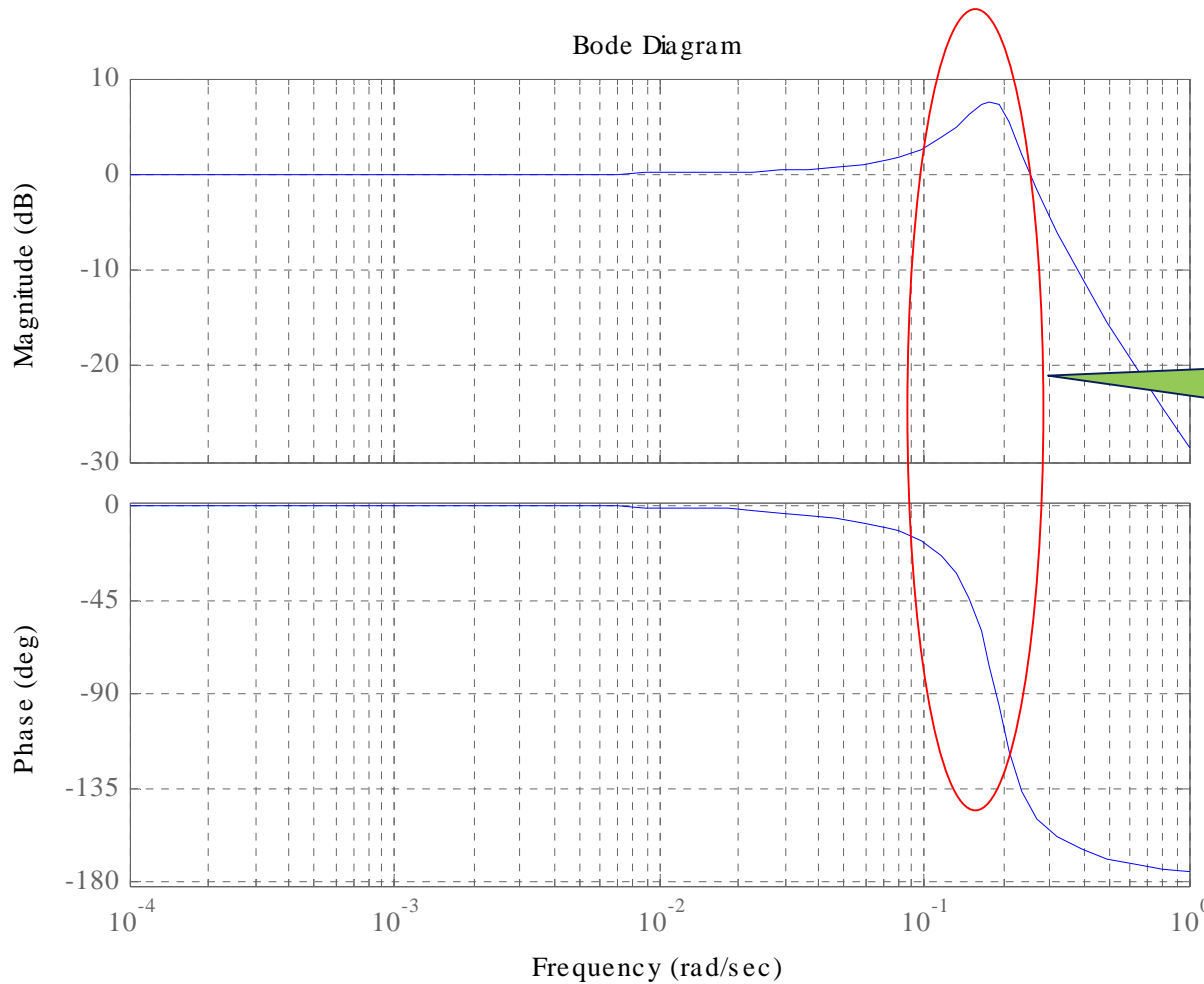
- Control problem

- Standard servo problem





Reference Tracking



Relative measurements only

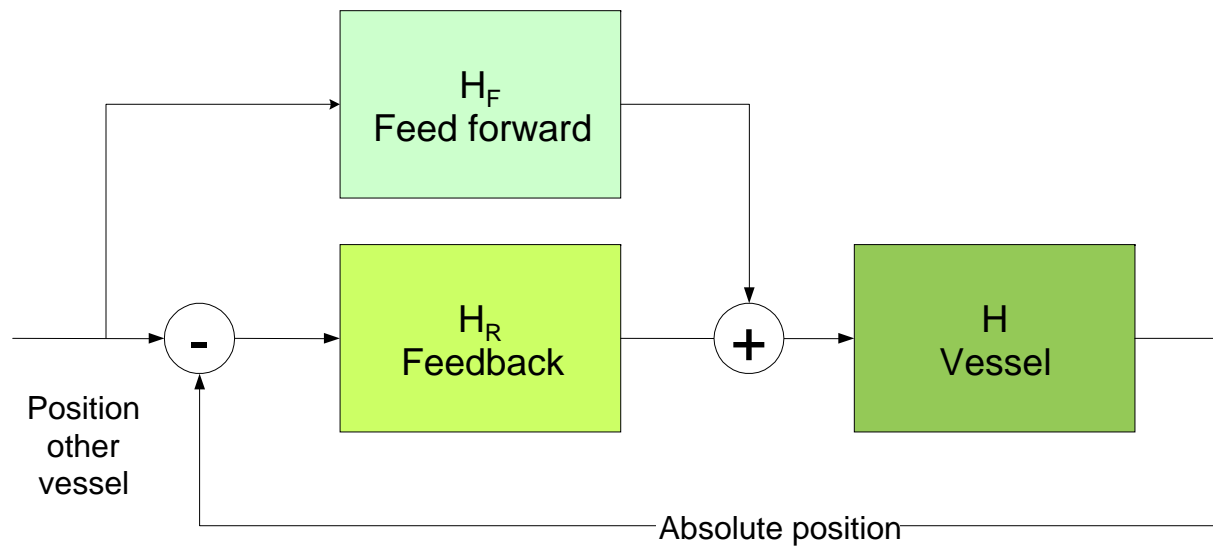
Bad combination

- Result:
 - Bad response
 - Possible instability



Control theory aspect

- Classical servo problem
 - Feedback loop
 - Feed forward



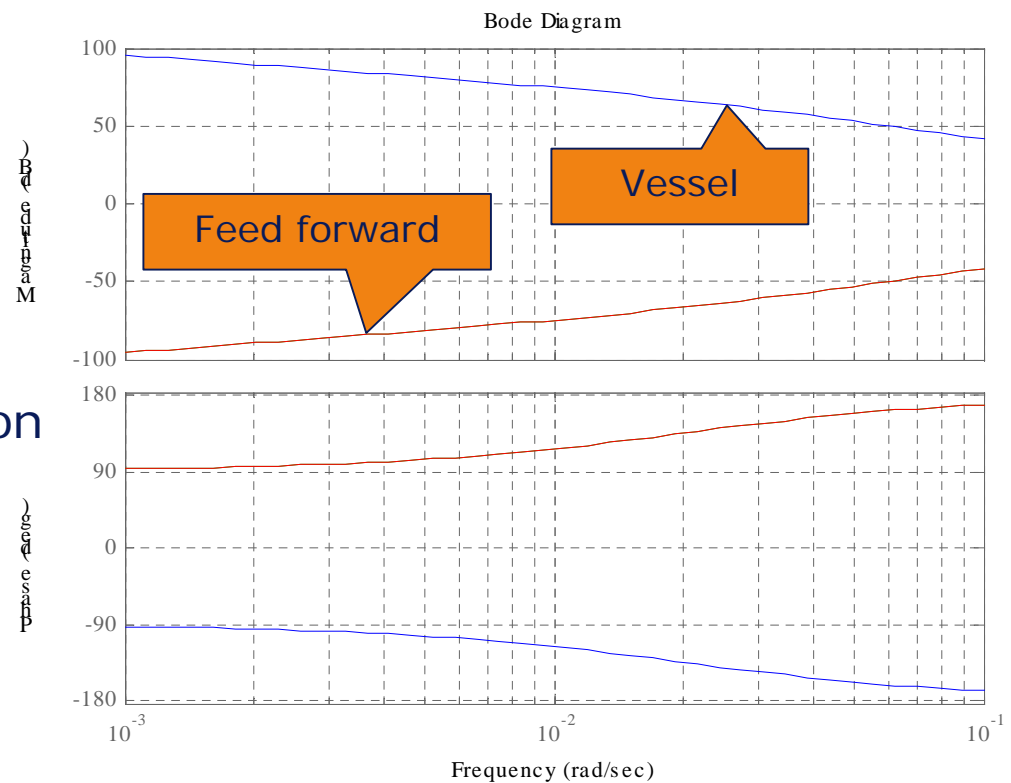


Feed forward

- “Optimal” feed forward
 - Invert vessel dynamics

$$H(s) = \frac{K}{s(1+Ts)}$$

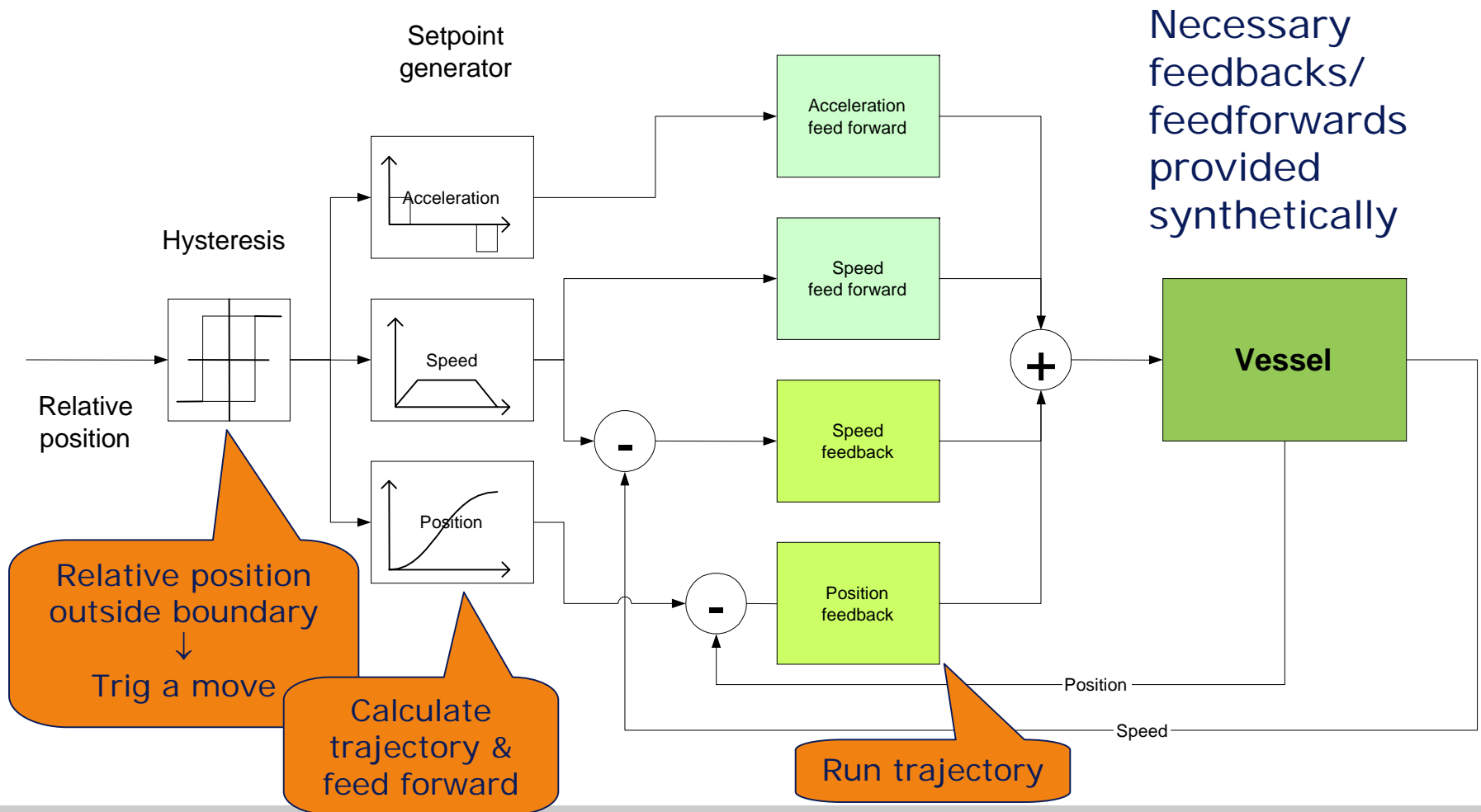
- Frequency independent response
- No relative speed / acceleration measurements available
- Differentiate relative position
 - Speed
 - Acceleration
- *Not Feasible*





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A practical solution

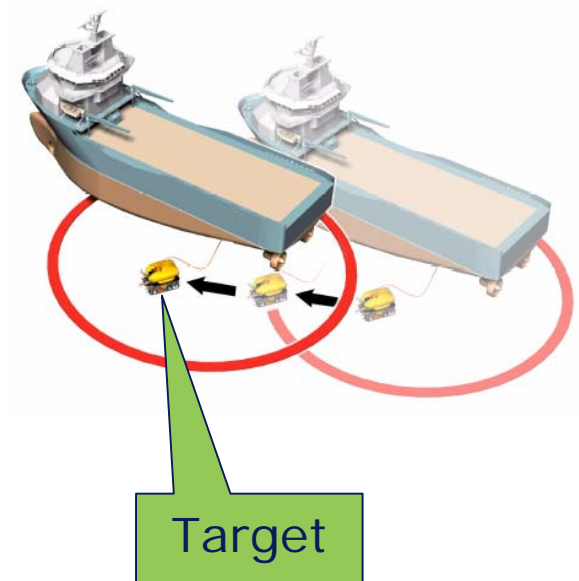




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The Follow Target Mode

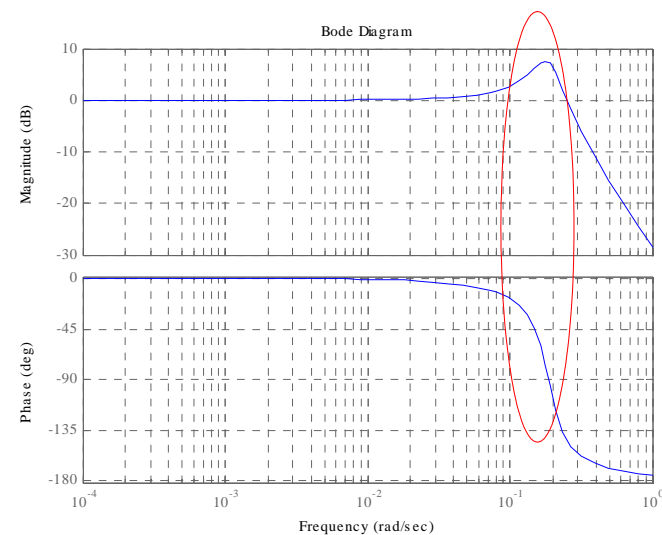
- Reaction Circle
 - Operator defined circle within which the target can move without causing the vessel to follow
 - When target at edge of reaction circle, position setpoint is updated automatically to restore the vessel position relative to the target
 - Reaction circle is redrawn around the new position of the target
- Multi targets
 - Follow target position
 - Follow target heading





Operational safety issues

- Need good absolute reference systems
 - Takes care of the stability of the DP control
- Need good relative reference systems
 - Takes care of correct distance to target
- No good idea to mix relative and absolute reference systems
 - Relative systems may “through out” absolute or vice versa
- What happens if all absolute reference systems are out of service?
 - Make relative measurements absolute!
- Anything to do with the control?



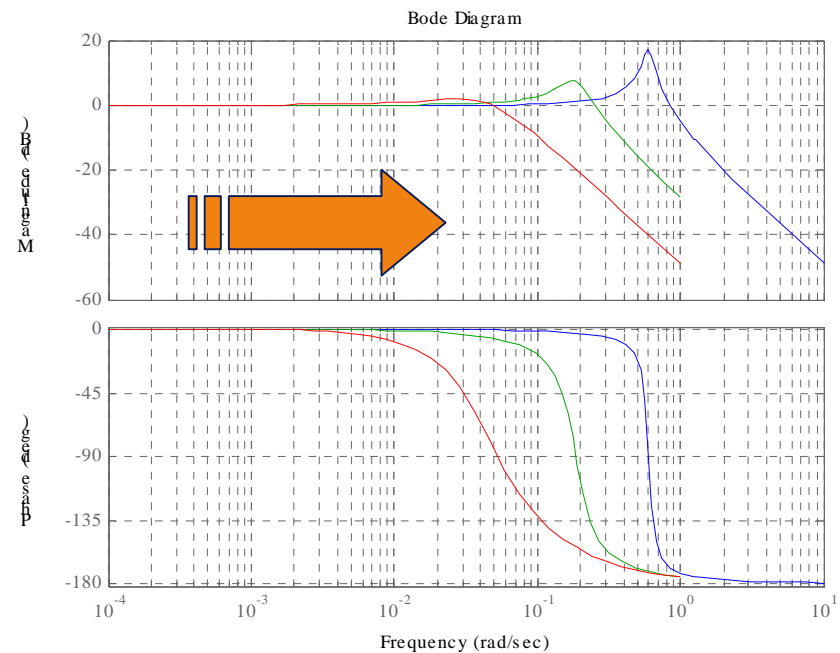


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Operational safety issues cont.

- Anything to do with the control?
 - Parametric changes not adequate
 - Structural problem
 - DP to be tuned to cope with typical target motions
- Class 2/3 requirement
 - Absolute reference system redundancy
 - DGPS/ DARPS , Acoustics, Taut wire
 - Relative reference system redundancy
 - RADIUS, Fanbeam, DARPS, Gangway
 - Both types crucial for safe operation
 - “Counting exercise” not sufficient

Effect of gain level





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Conclusions

- Special control algorithms needed
 - Possible stability problems
 - Feed forward from target motion necessary
- Safety of operation
 - Emphasis on both relative AND absolute reference systems

Thank you for your attention



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