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Enhanced Safety and Reliability for Trains Through Fault Tolerant Control

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1st Year PhD

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Project Outline

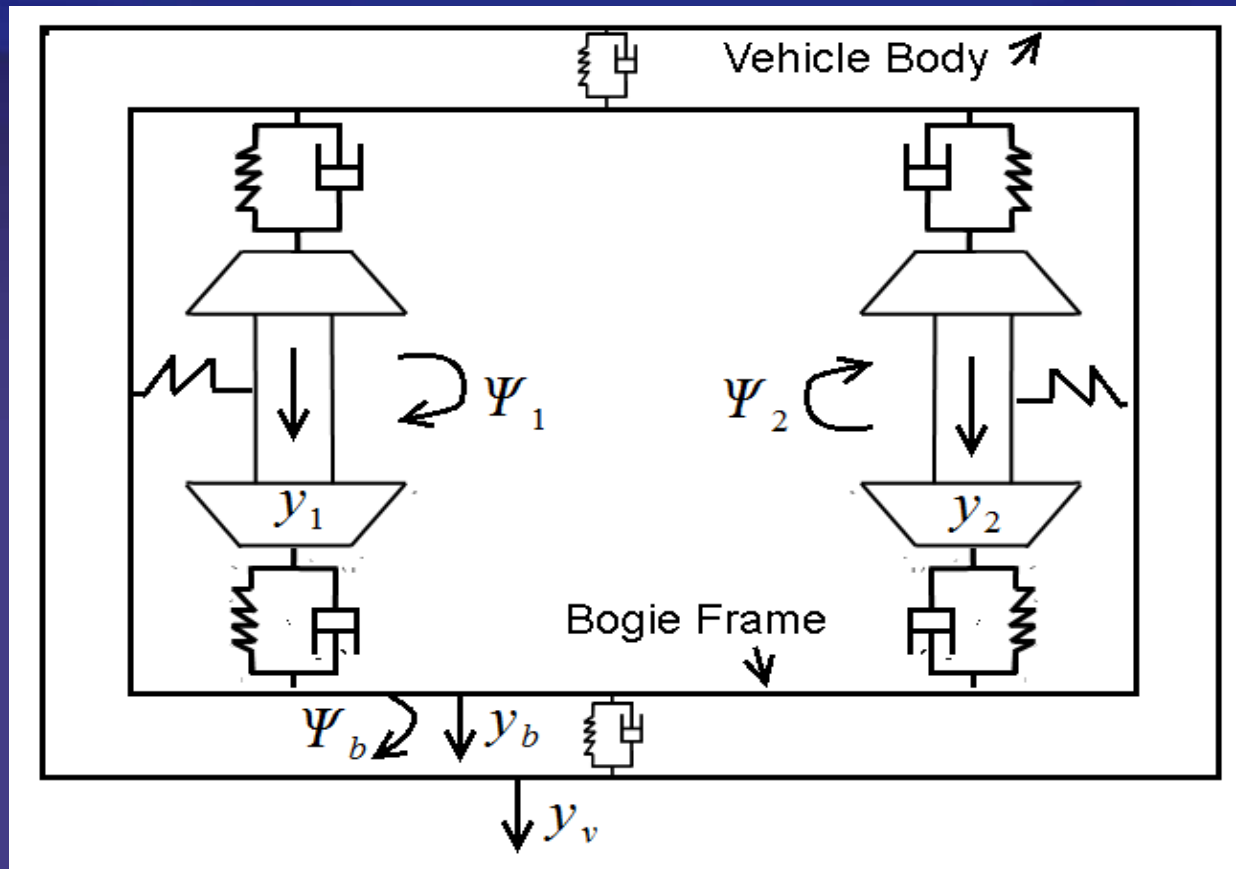
- Investigate fault tolerant control methods for rail vehicle suspension
- Lead to safer systems and improved reliability
- Active control for better performance and stability

Project Plan

- Computer models and simulation of rail vehicle dynamics
- Focus on active primary suspension systems.
- Development of fault tolerant control algorithms

Dynamic Models

- Conventional solid-axle wheelset model
- Linear Vehicle model with 7 degrees of freedom
- 14th Order model



Dynamic Models

- High level of parameter variations (Creep coefficients and conicity)
- Significant non-linearities from wheel-rail contact

Focus on Suspension

- Failures in suspension system cause problems.
- Impact of quality and comfort of ride
- Increased wear of rail and wheel
- In extreme cases passenger safety affected

Focus on Suspension

- Conventional rail vehicles stabilise wheelsets with mechanical yaw stiffness
- Trade-off between natural curving performance of the wheelset and system stability
- Requires vehicle parameters to be carefully designed so that the critical speed of the system is higher than the maximum operational speed

Passive Suspension

- Wheelsets stabilised with mechanical yaw stiffness attached between wheelset and bogie frame
- Forces wheelsets away from ideal positions
- Results in increased creepage and increased wear on wheels
- At lower speeds flange contact and noise possible

Passive Suspension

Tight curve (radius of 300m) at 25m/s



Active Control of Suspension

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- Active control of suspension to steer wheelset around curves
- Actuator attached between wheelset and bogie
- Avoids passive compromise solutions between steering and stability

Active Control of Suspension

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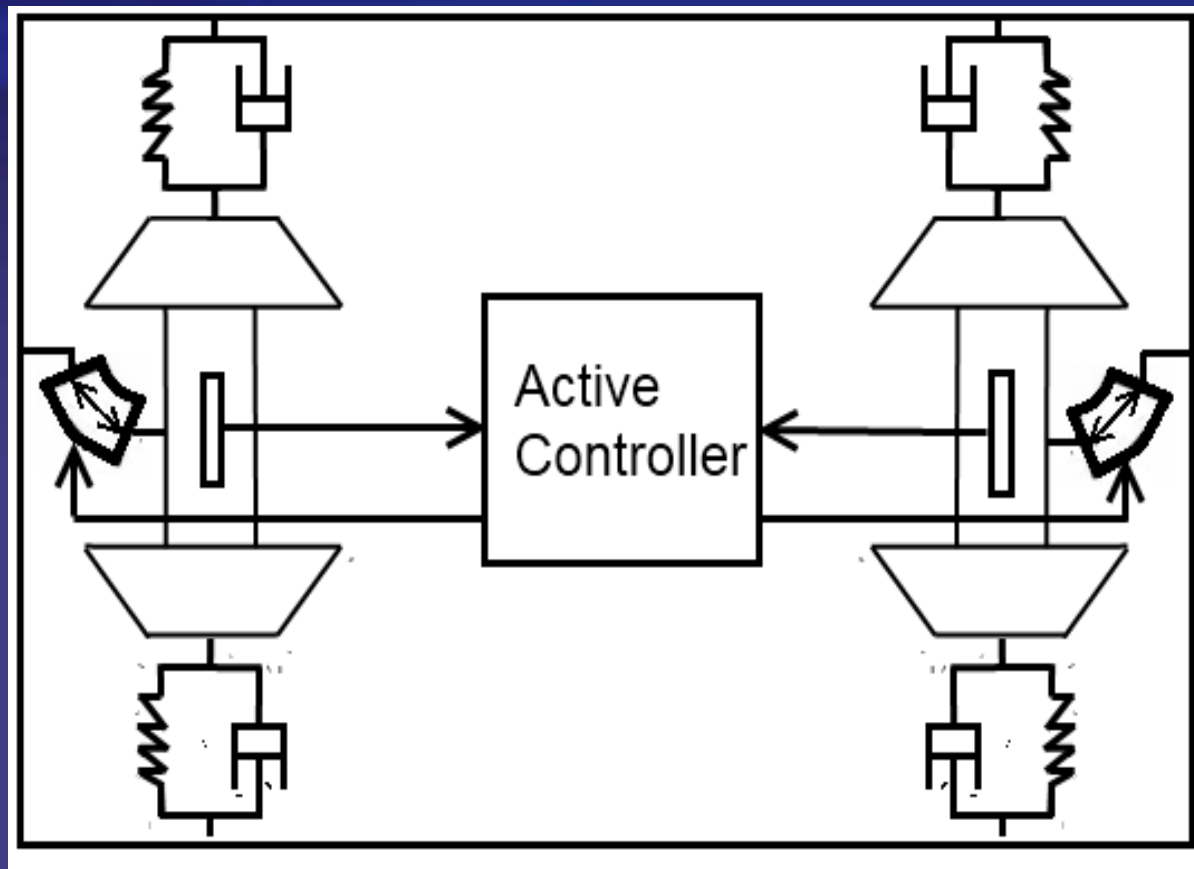
- Results show improved performance of rail vehicles on straight and curved tracks
- Smaller lateral displacements of wheelsets along straight and curved tracks, reduced wear of wheels as a result of decreased flange-rail contact

Fault Tolerant Control

- Active control improves steering performance of vehicle, however faults may occur in suspension
- Fault Tolerant control to allow system to continue operating despite faults

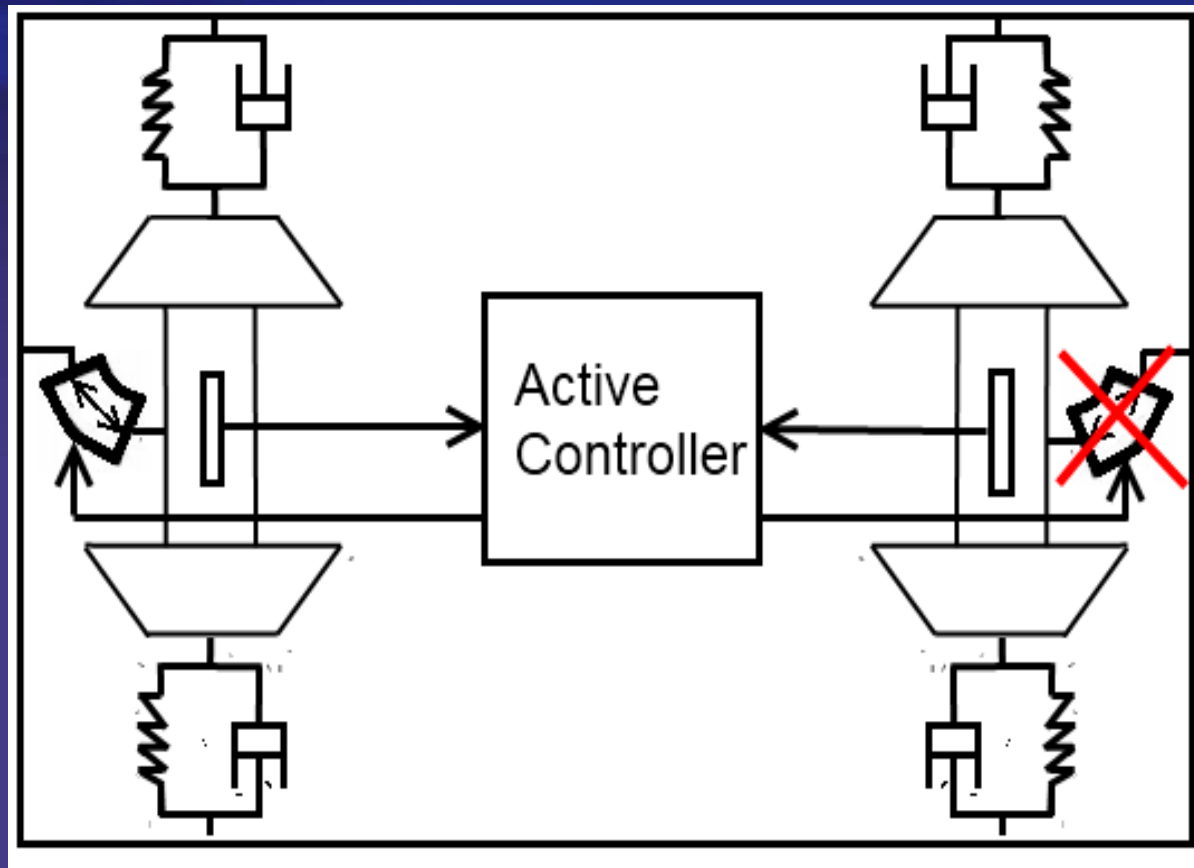
Example

- Active controller directing steering of front and back wheelsets dynamically



Example

- Any failing in either yaw actuator can be compensated for



Process

- Detect problem
- Fault containment and compensation

Benefits

- Early detection of faults
- Reduced wheel rail contact
- Safety!

Thanks

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- Thank you