

Eindhoven, February 4TH 2010

MYMOSA WP4 – Biomechanics

**Numerical modeling of motorcyclist
active behavior**

Outline

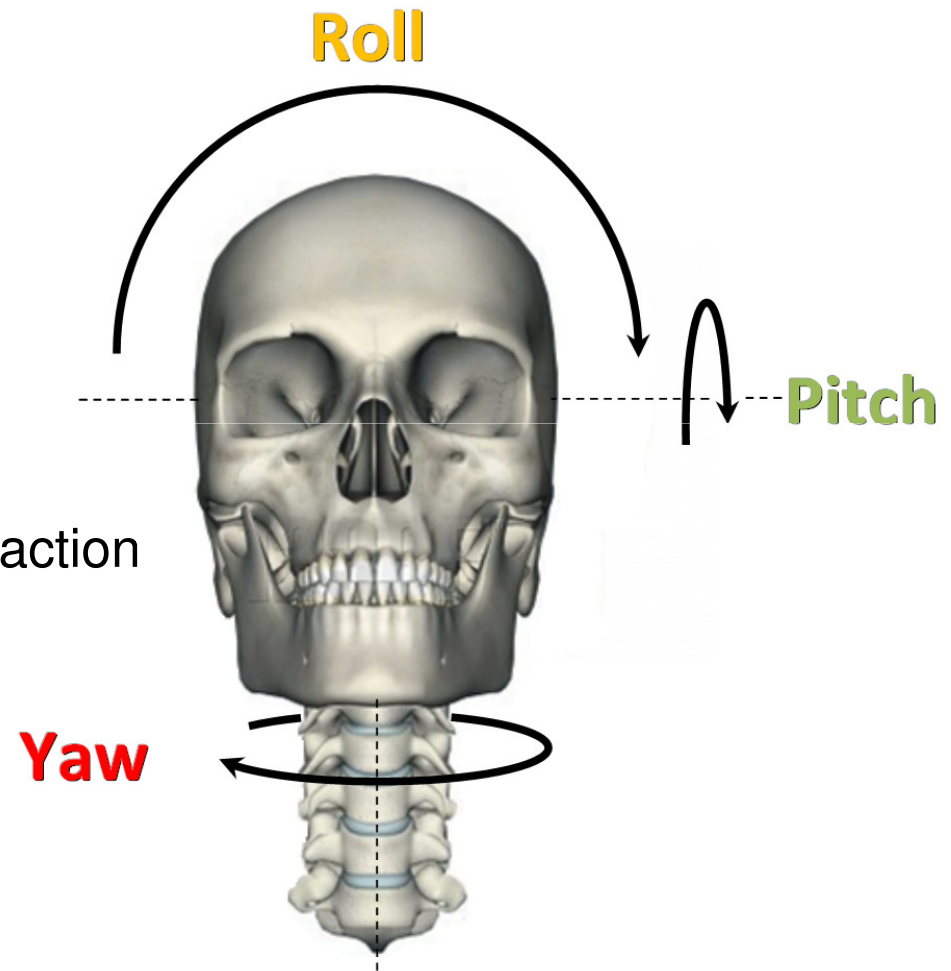
- Objectives & Problem Description
- Previous Work
- New Strategy
- Some Results
- Next Steps

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- **Objectives & Problem Description**
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Objectives

- Biofidelic head stabilization and reactions in 3 rotational axis:
 - ‘Bracing’: muscle co-contraction prior to large ‘expected’ acceleration fields.
 - Biofidelic control.



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Previous work: Relevant Scenarios?

Low speed, head-on urban collisions!

Low speed so that a neck protective device adds evident value: otherwise head injuries (thus helmet) and abrasion damage (thus suits) become the limiting factor and hence deserve R&D priority

Head-on seems to be dominant in PTW-vs-car crashes: a blocked PTW and reasonably effective helmet lead to frequent neck/cervical injury caused by bending after “flight and impact”

Urban riding demands unobtrusive devices/equipment which can provide protection for medium severity loading – at high speeds almost complete rigidity is needed, which is too cumbersome...

Previous Work: Strategy

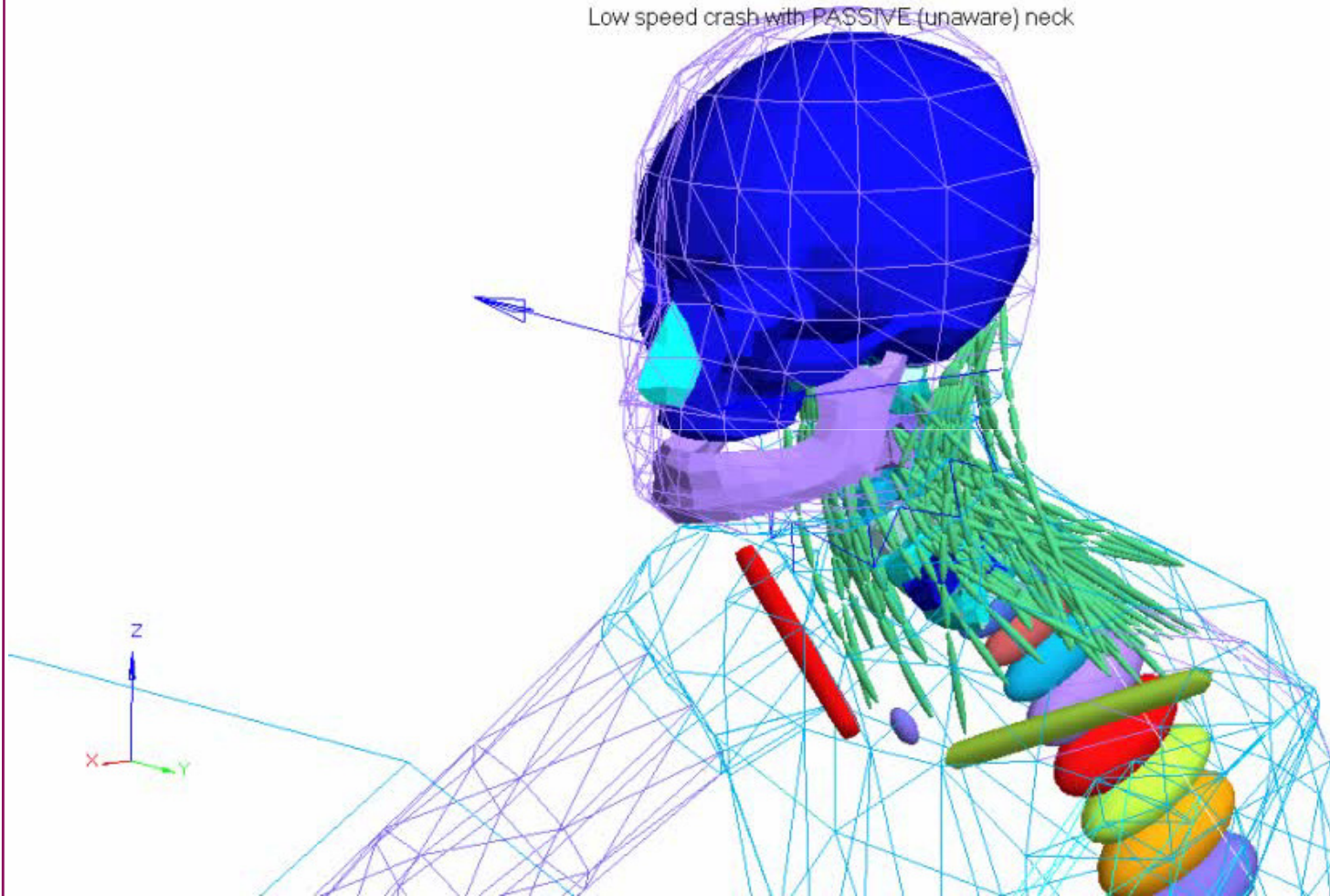
- 2 PIDs were implemented for pitch and roll
- Muscles were catalogued into
 - “flexors”,
 - “extensors”,
 - “left rollers” and
 - “right rollers”,

and used as actuators for the PIDs.

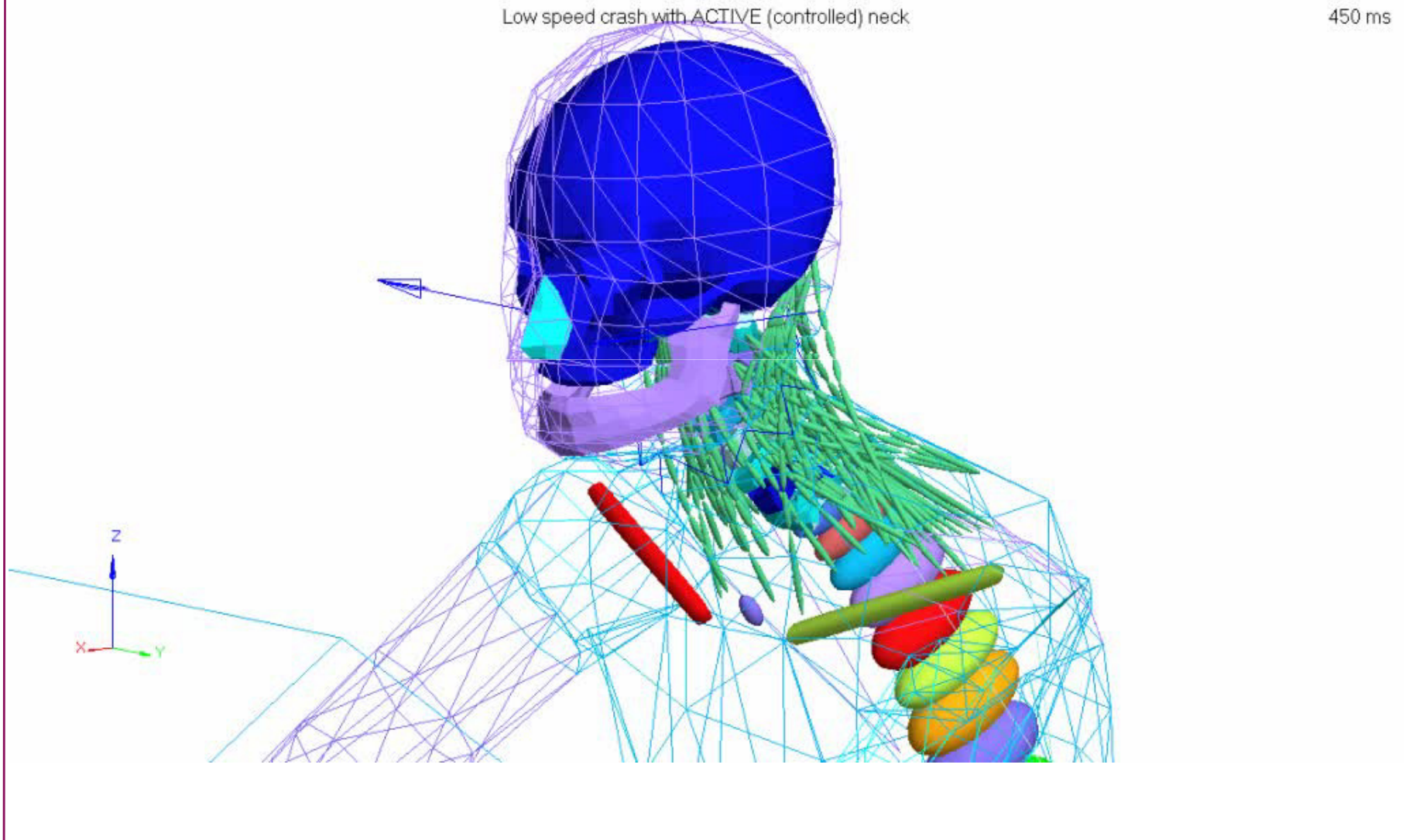
Previous Work: Where a sleepy rider would look like this...

Low speed crash with PASSIVE (unaware) neck

0 ms






Previous Work: ... an aware one would look like this...



Outline

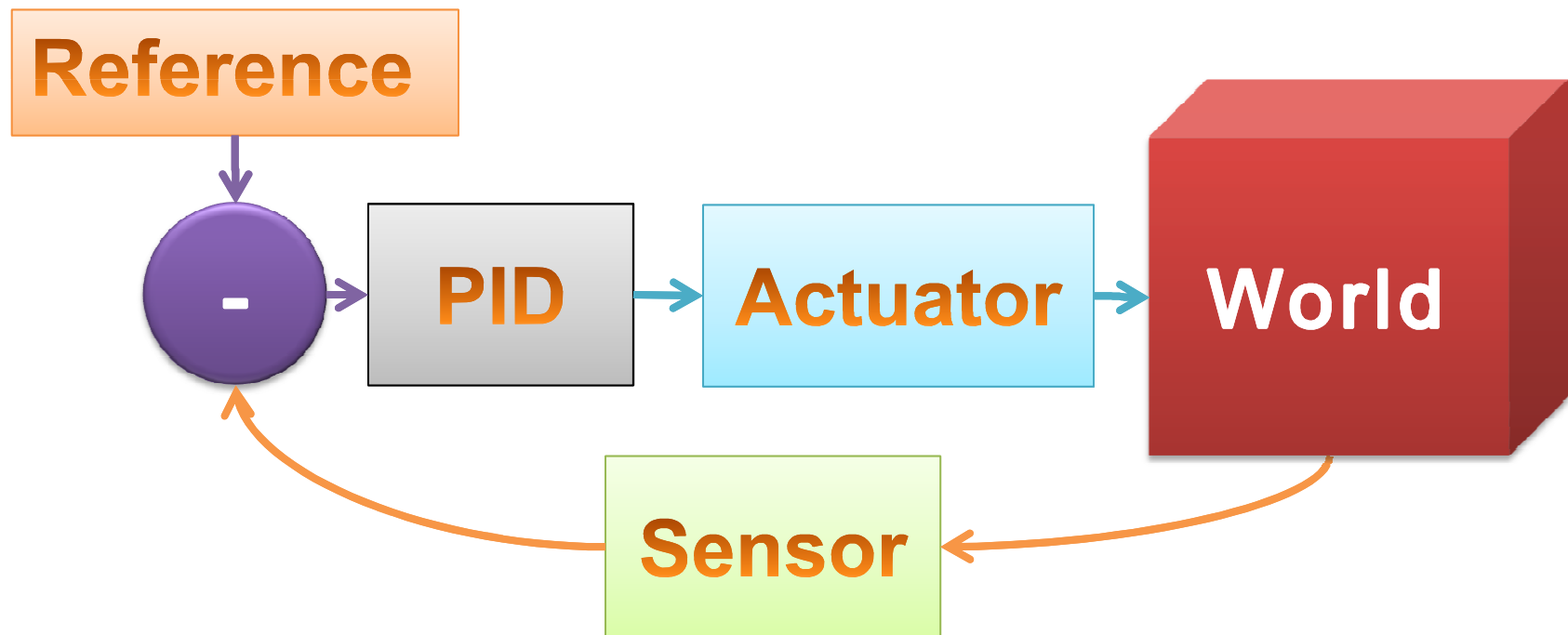
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Control Strategy

- Simplest approach: 3 PIDs
- If I was a PID, what would I want?
 - My own sensor 
 - My own actuator 
 - Nobody messing with my work.
 - (So I should mess with no-one's) 

Control Strategy

- Roll, pitch and yaw are already independent rotations... so if only we had a one “roll”, one “pitch” and one “yaw” actuator...



Control Strategy

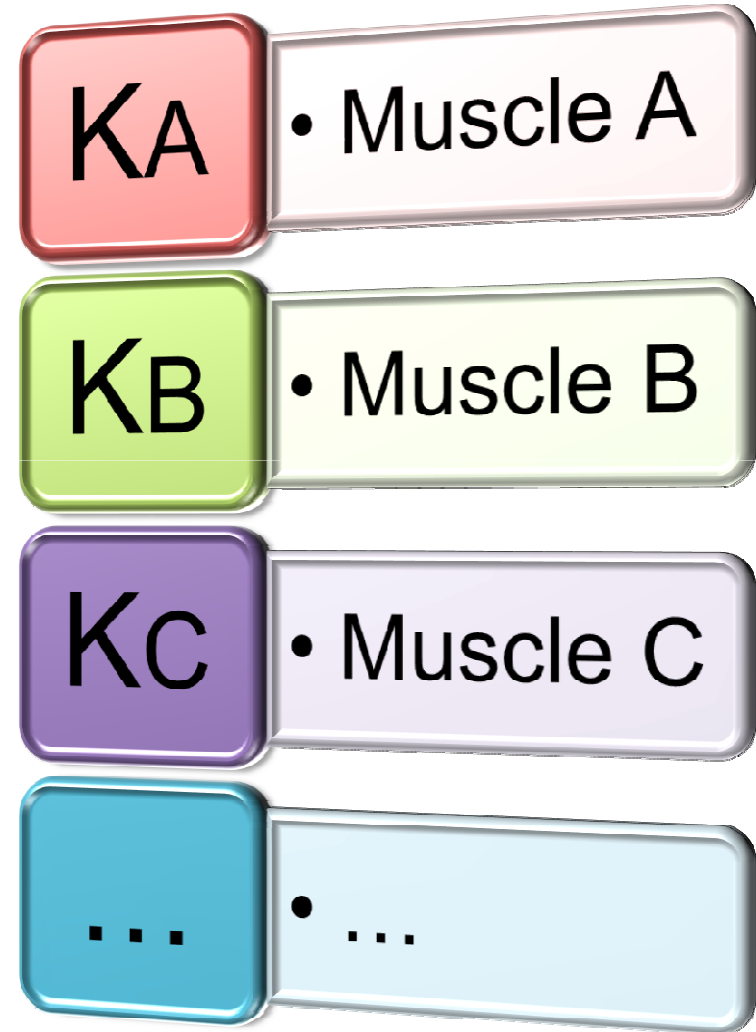
- Say we measure the effect that muscles have on the neck.

	Total Moment	Roll	Pitch	Yaw
Muscle 1	MT1	Mx1	My1	Mz1
Muscle 2	MT2	Mx2	My2	Mz2
Muscle 3	MT3	Mx3	My3	Mz3
...

- And then we activate all of them... with a factor multiplying every muscle's activation...

Control Strategy

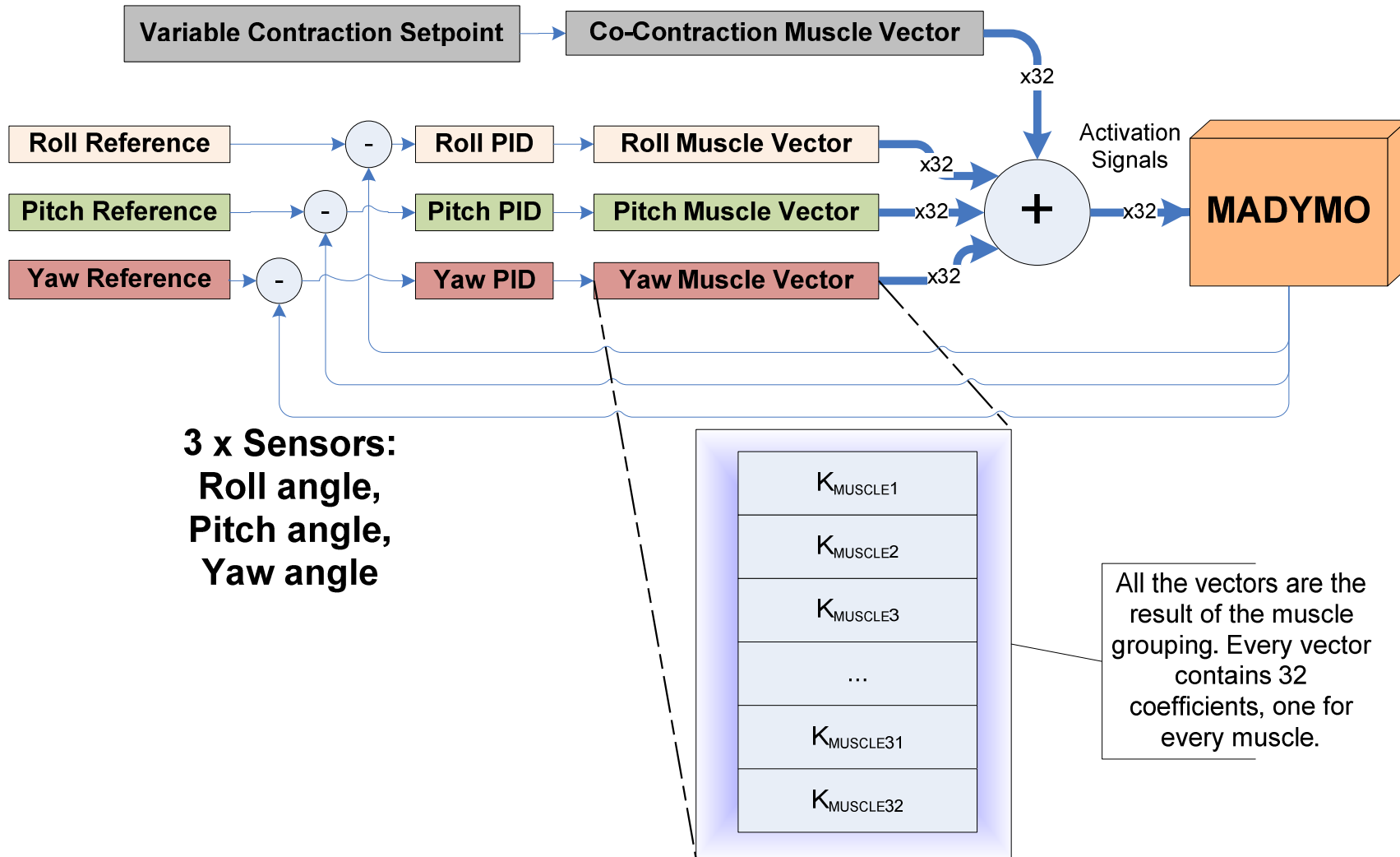
- Say we choose those factors so that the end result is a torque exerted only in roll, pitch or yaw...
- Voilà! We have our actuator.



Control Strategy

- What about co-contraction?
 - If we think of co-contraction as contracting agonist muscles and antagonist muscles equally...
 - Then co-contraction is just another muscle group!
 - Only that in this case, the desired resultant torque is zero...

Control Strategy



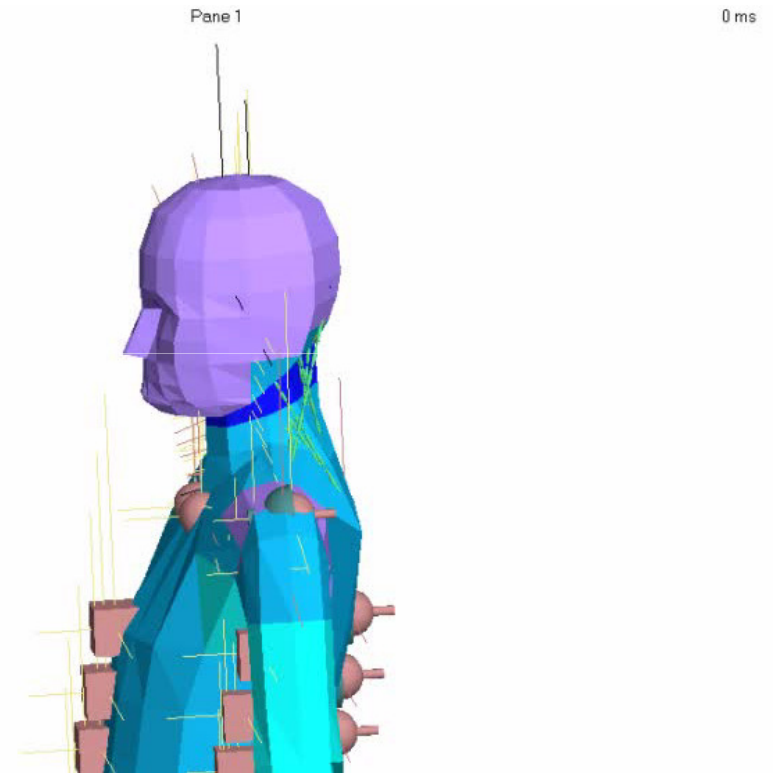
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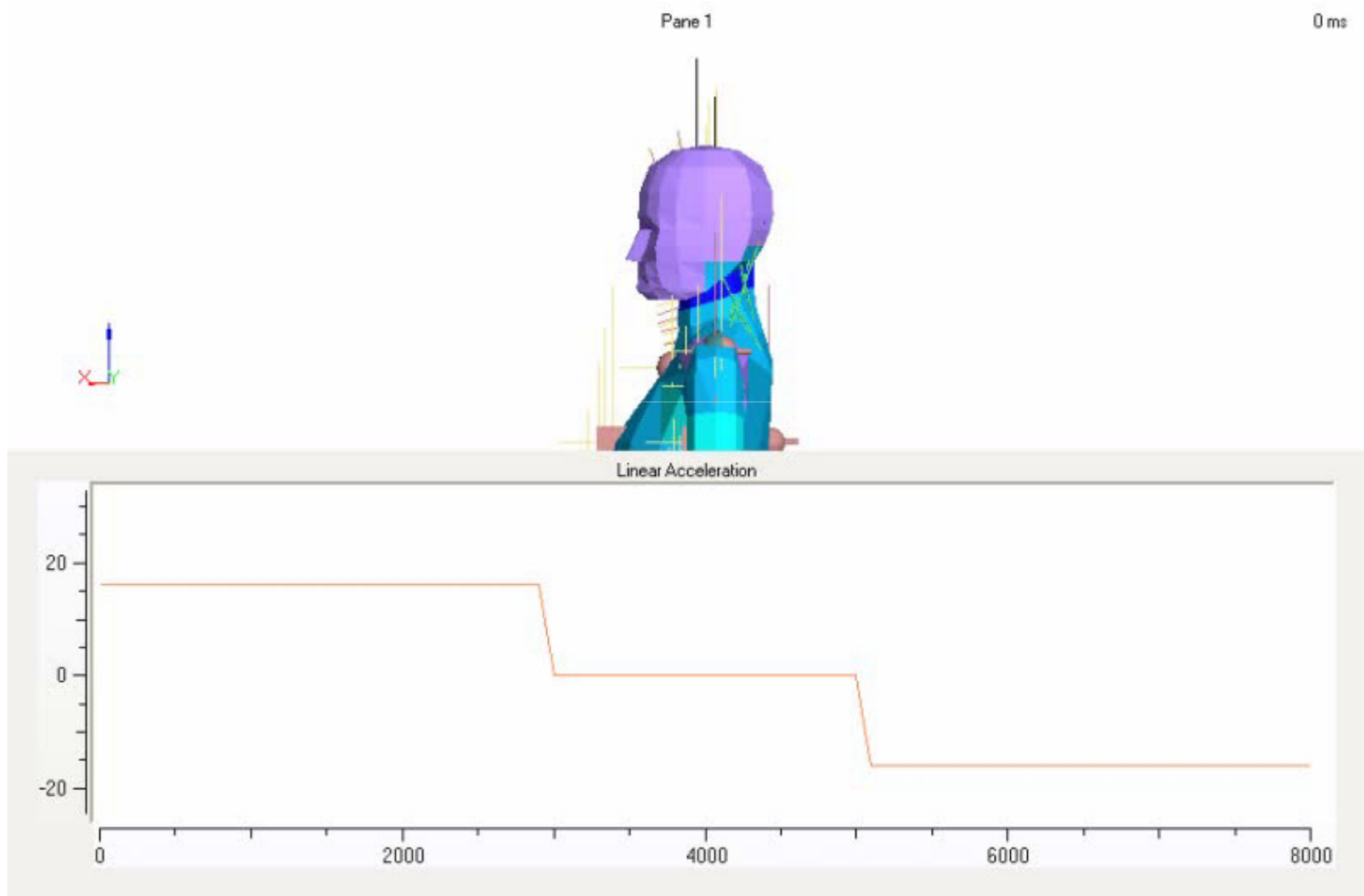
Some Results

- Simulation settings (1):
 - Only gravity
 - Sim. time: 3 seconds
 - Initial conditions:
 - Position: neutral
 - Muscles fully relaxed

- Simulation settings (2):
 - Gravity plus
 - 1.7g frontal for 3 sec.,
 - 0.0g frontal for 2 sec
 - 1.7g frontal for 3 sec
 - Sim. time: 8 seconds
 - Similar Initial conditions:



Some Results



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Next Steps

- Biofidelic muscle grouping
 - Optimization algorithm:
 - Fatigue
 - Energy expense
 - Muscle Stress
 - Etc.
- Complete tuning
- Full validation (LMU sled tests & other)



Questions?



Thank you!

