

From Drones to Automated Driving

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Drones and Automated Vehicles



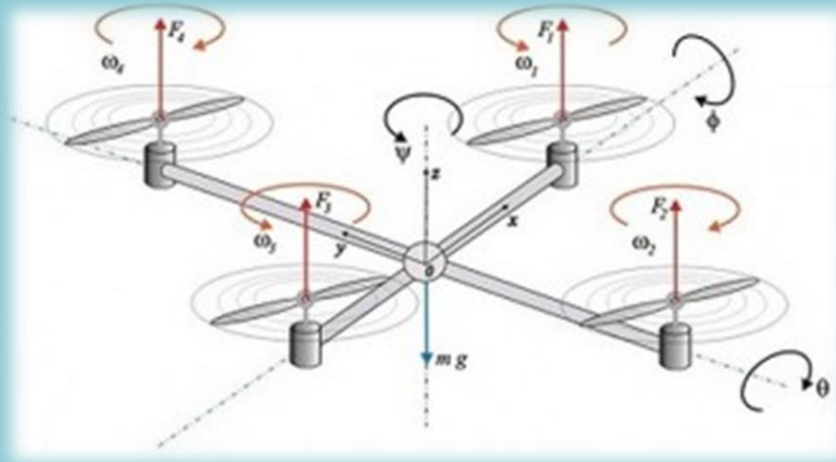
Baidu's Yun Xiao cars make debut at World Internet Conference

Levels of Driving Automation for On-Road Vehicles

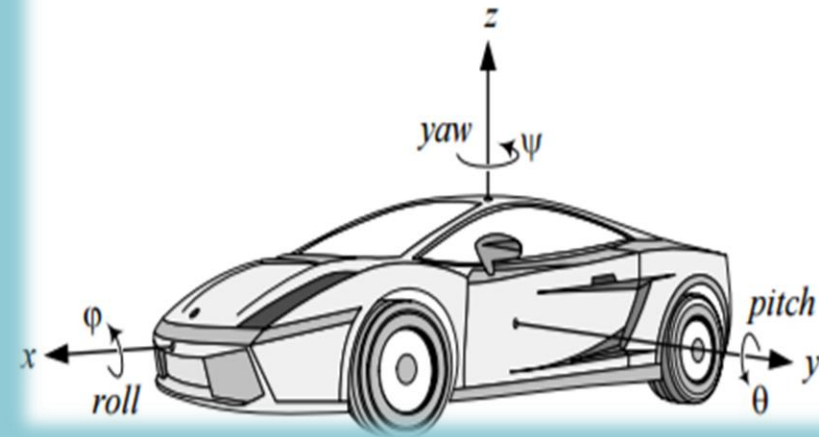
SAE International's levels of driving automation for on-road vehicles

Level	Name	Narrative definition	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of <i>dynamic driving task</i>	System capability (<i>driving modes</i>)	BA/SI level	NHTSA level
Human driver monitors the driving environment								
0	No Automation	the full-time performance by the <i>human driver</i> of all aspects of the <i>dynamic driving task</i> , even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a	Driver only	0
1	Driver Assistance	the <i>driving mode</i> -specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the <i>human driver</i> perform all remaining aspects of the <i>dynamic driving task</i>	Human driver and system	Human driver	Human driver	Some driving modes	Assisted	1
2	Partial Automation	the <i>driving mode</i> -specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the <i>human driver</i> perform all remaining aspects of the <i>dynamic driving task</i>	System	Human driver	Human driver	Some driving modes	Partially automated	2
Automated driving system ("system") monitors the driving environment								
3	Conditional Automation	the <i>driving mode</i> -specific performance by an <i>automated driving system</i> of all aspects of the <i>dynamic driving task</i> with the expectation that the <i>human driver</i> will respond appropriately to a <i>request to intervene</i>	System	System	Human driver	Some driving modes	Highly automated	3
4	High Automation	the <i>driving mode</i> -specific performance by an <i>automated driving system</i> of all aspects of the <i>dynamic driving task</i> , even if a <i>human driver</i> does not respond appropriately to a <i>request to intervene</i>	System	System	System	Some driving modes	Fully automated	3/4
5	Full Automation	the full-time performance by an <i>automated driving system</i> of all aspects of the <i>dynamic driving task</i> under all roadway and environmental conditions that can be managed by a <i>human driver</i>	System	System	System	All driving modes	.	

Vehicle dynamics (simplified models)



Quadcopter



Vehicle

Degrees of Freedom (DoF)

Vehicle motion (nonholonomic constraint of the road)

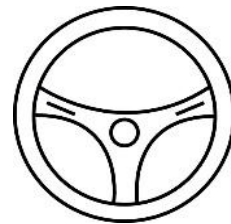
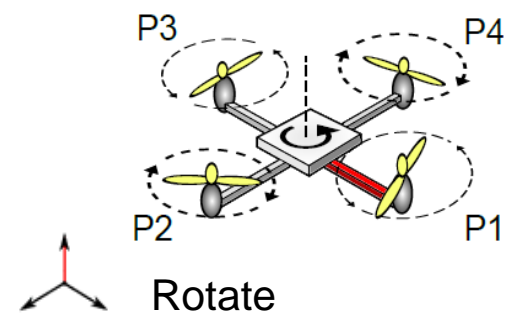
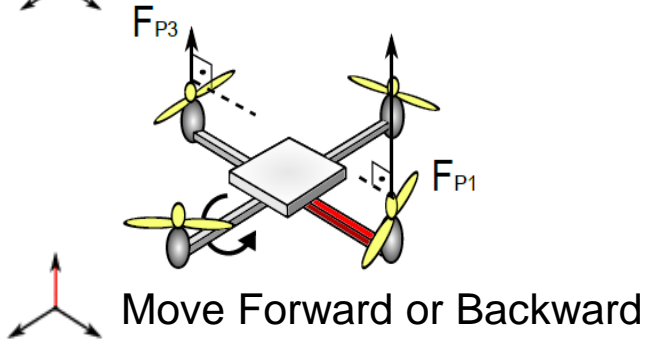
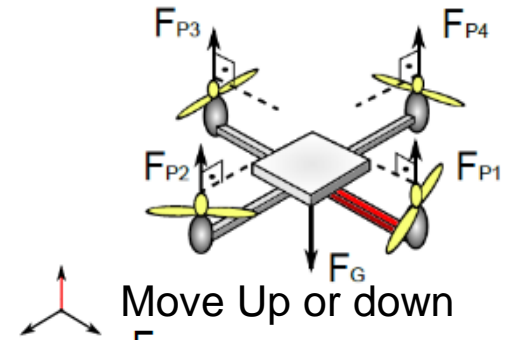
- Longitudinal translation (forward backward motion)
- Lateral translation (side slip)
- Vertical translation (bounce or heave)
- Rotation around longitudinal axes (roll)
- Rotation around longitudinal axes (pitch)
- Rotation around longitudinal axes (yaw)

Degrees of Freedom (DoF)

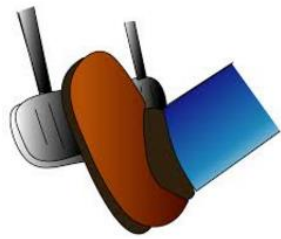
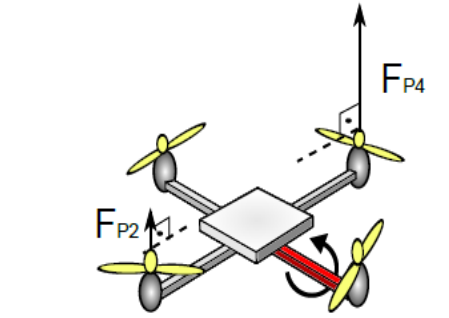
Drone motion (Quadcopter)

- Longitudinal translation (forward backward motion)
- Lateral translation (side slip)
- Vertical translation (bounce or heave)
- Rotation around longitudinal axes (roll)
- Rotation around longitudinal axes (pitch)
- Rotation around longitudinal axes (yaw)

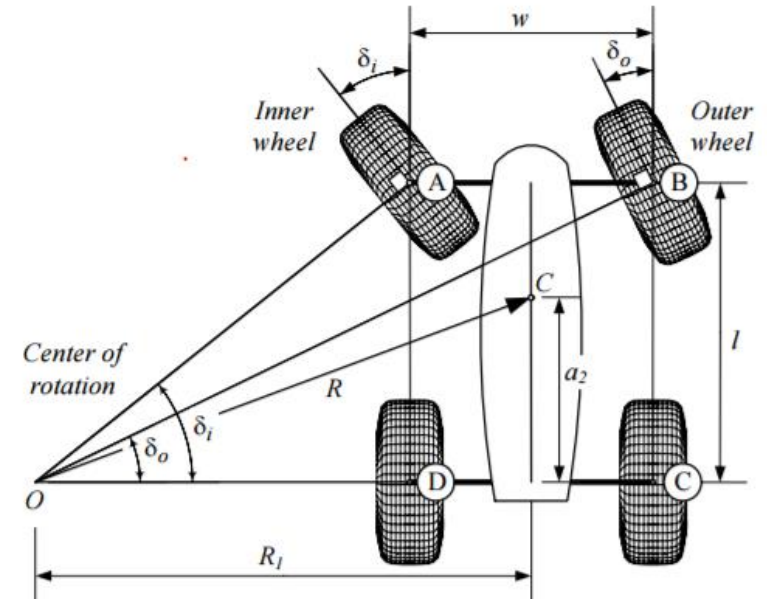
Human Control Interface



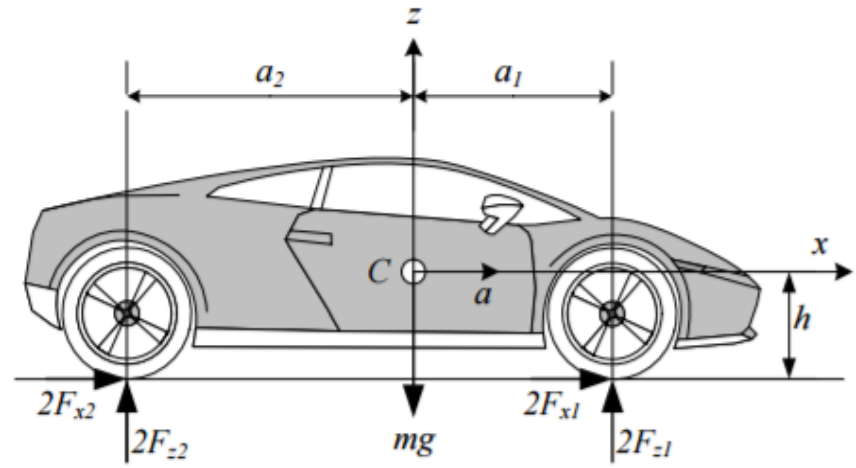
Drive Left or right



Drive Forward or Backward



A front-wheel-steering vehicle and steer angles of the inner and outer wheels



Accelerating car on road



Summary of human motion control interface

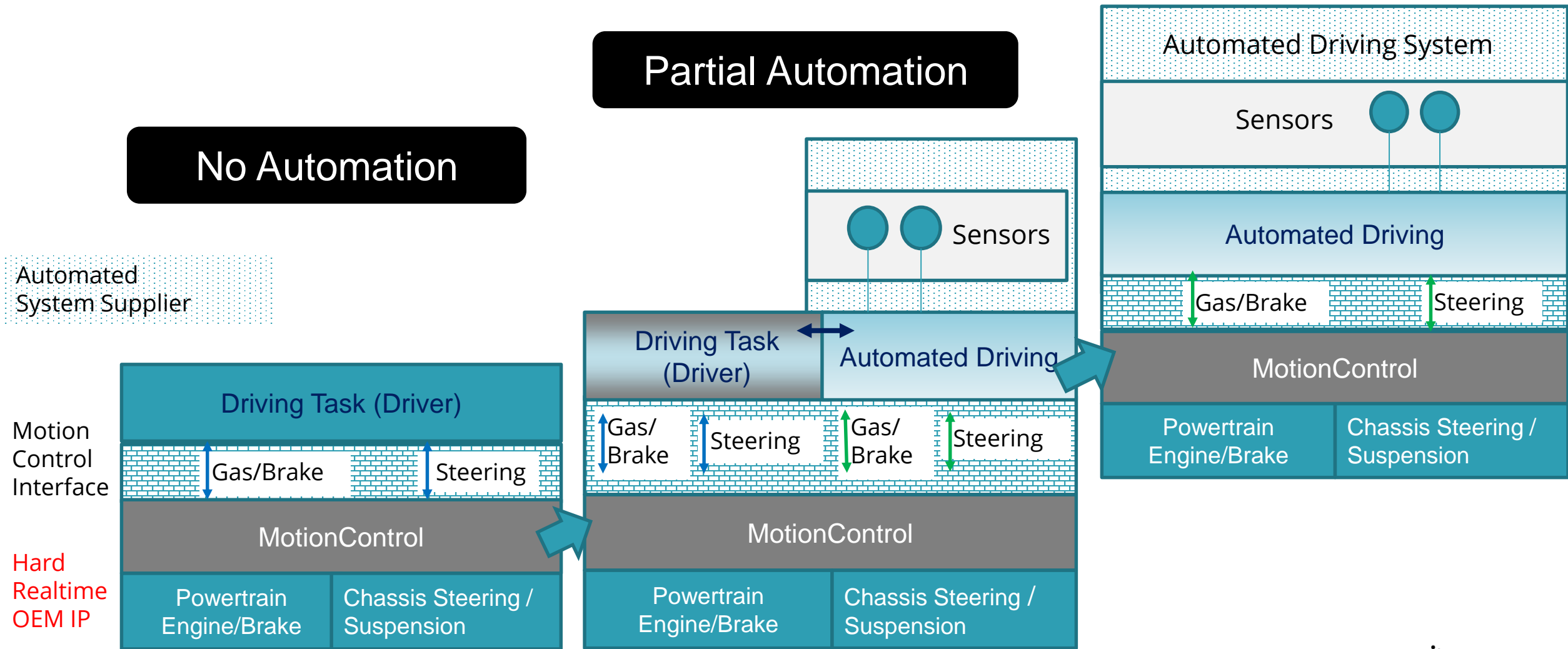
- Controls are abstracted
- Controls are aggregated to serve for functions
- Limited aggregated controls are exposed

Automated Driving

Full Automation

Partial Automation

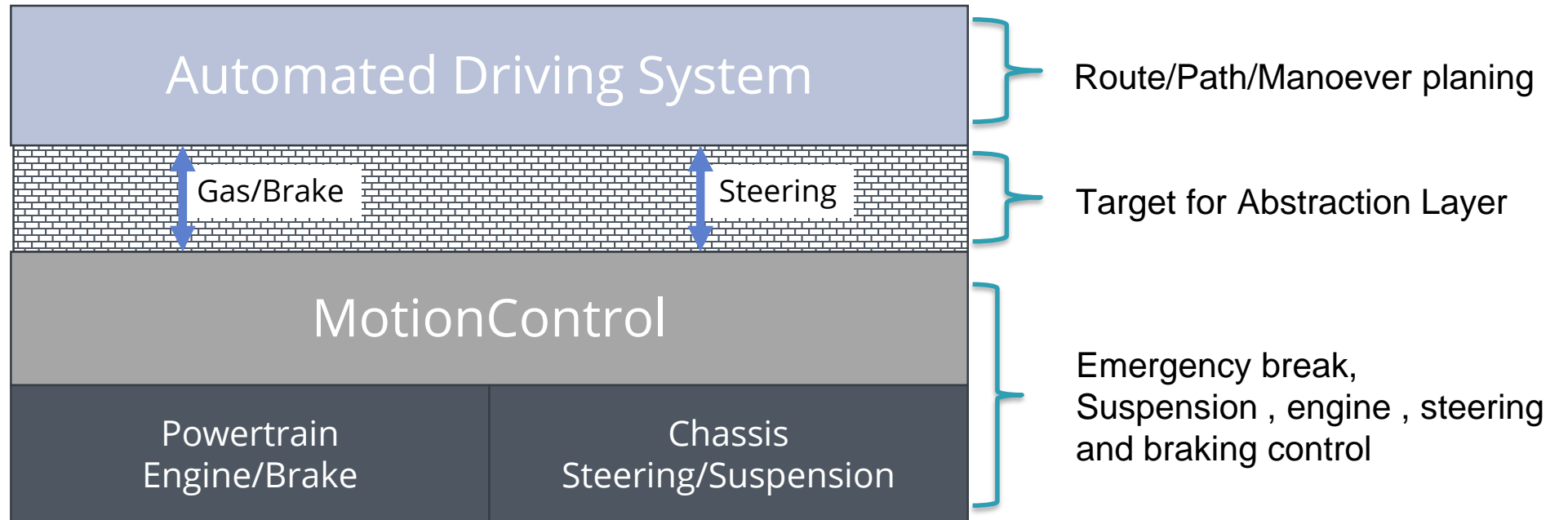
No Automation



Motion Control supervises vehicle state / owns safety critical sensors (Lidar/Radar, Speed, Accelerometer,...)
Monitors the MotionControl Interface (validates the request /profiles)

Automated Driving

Motion Control Interface Abstraction



Motion Control supervises vehicle state/ owns safety critical sensors
(Lidar/Radar, Speed, Accelerometer,...)
Monitors the MotionControl Interface (validates the request /profiles)

Training the Driving task

Record Driving task Videos

Capture Brake/Steering and Gas values

Train a DNN based on this records.

Embedd DNN in vehicle , which is fed with camera input

DNN produces Brake/Steering and Gas values

Feed them into Motion Control Layer

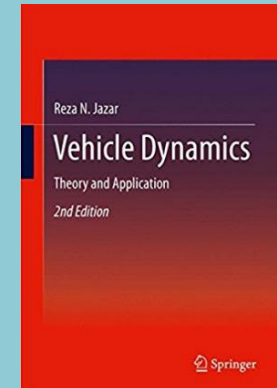
-> DNN- Autopilot

Proposal for GENIVI

- Specify Motion Control
- Provide reference implementation
- Use Genivi methodology (FIDL, Franca,..) for modeling the Motion Control abstraction

References

- <https://theaviationist.com/tag/general-atomics-mq-1-predator/page/5/>
- Vehicle Dynamics: Theory and Application



Thank you!

Visit GENIVI at <http://www.genivi.org> or <http://projects.genivi.org>

Contact us: help@genivi.org

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