



Robotics, Automation and Control

# Modular Robotic Vehicle (MRV)

Battery powered electric vehicle with full drive by wire system

Innovators at the NASA Johnson Space Center in collaboration with an automotive partner have developed the Modular Robotic Vehicle (MRV). This fully electric vehicle is well-suited for busy urban environments, industrial complexes, or large resort areas. The MRV combines a number of innovative technologies that are available for licensing as a whole system or individually as components. The MRV has no mechanical connections to the propulsion, steering, or brake actuators-- instead the driver relies on control inputs being converted to electrical signals and transmitted by wire to the motors within the vehicle. The MRV has a fully redundant, fail-operational architecture that is paramount to the safe operation of a by-wire system. The MRV is driven by four independent wheel modules, called e-corners. Each e-corner can be rotated +/- 180 degrees about its steering axis. Imagine being able to parallel park by simply driving sideways into a tight spot with ease. With the new MRV technology, this dream is now a reality.

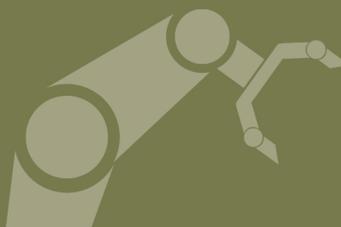
## BENEFITS

- Lighter and efficient due to eCorner design
- Full drive-by-wire systems (propulsion, steering and braking)
- Redundant fail-operation architecture
- Four independent wheel modules
- 180 degree steering actuation
- Liquid cooled in-wheel propulsion motors
- Remote driving capability
- Software allows for fine control of steering and torque of each wheel individually. This allows for vehicle dynamic algorithms not possible in traditional automobiles

## APPLICATIONS

- Automotive
- Industrial Vehicles
- Entertainment
- Motorized Wheelchairs
- Transportation, Delivery and Service
- Airport Transportation
- Miniaturized Mobility Systems

technology solution

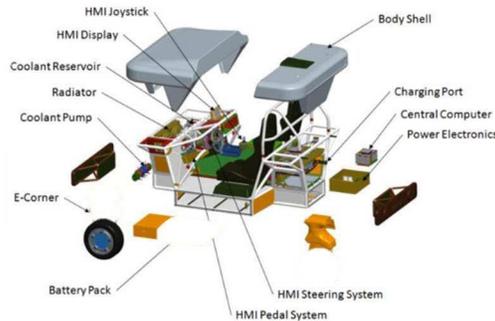


## THE TECHNOLOGY

The Modular Robotic Vehicle (MRV) is a vehicle designed for transportation in congested areas. The MRV is relatively small, easy to maneuver and park. The MRV was designed without a central power plant, transmission, fuel tank, and direct mechanical linkages between driver input devices and the actuators used to accelerate, brake and/or steer the car. These core vehicle functions are located at the corners of the vehicle in a modular electric corner assembly or eCorner. Because the MRV uses a by-wire control system, substantial space and weight is conserved compared to conventional designs. Moreover, the functional capabilities that are provided by the individual eCorners enable control of the vehicle in a variety of different operating modes.

The eCorners provide significant flexibility in driving options. For example, the driving mode can be switched so that all four wheels point and move in the same direction achieving an omni-directional motion or all wheels can be pointed perpendicular to the center of the vehicle allowing rotation around its center axis. This mode makes some driving maneuvers like parallel parking as easy as driving next to the spot, turning the wheels 90 degrees, and driving into the open spot in a sideways motion. Each eCorner includes its own redundancy to protect for electrical failures within the systems. The driver can choose to control the vehicle with a conventional steering wheel or add inputs through a multi-axis joystick for additional control in some of the more advanced drive modes. The vehicle has the propulsion motors located inside of each eCorner with the capability of producing 190 ft-lbs of torque with a current top speed of 40 mph. An active thermal control loop maintains the temperatures of these high powered motors and a separate thermal loop cools the avionics and the custom lithium-ion battery packs. The linked vehicles are able to exchange or share control data and electrical power. Finally, the MRV has remote driving control capability.

- Design speed: 64 kph (40 mph)
  - Currently computer limited to 25kph (15mph)
- Curb weight: 900 kg (2000 lb)
- Footprint: 2.15 x 1.55m (7' x 5')
- Drive-by-wire without mechanical backup



Modular Robotic Vehicle Design Diagram



eCorner allows for 180 degree steering at each wheel.

## PUBLICATIONS

Patent No: 9085302; 9102331; 9381802; 9254866; 9266518

Patent Pending

To learn more about the MRV unique features, please watch this video:  
<https://youtu.be/f-VUHdmjytM>

National Aeronautics and Space Administration

Agency Licensing Concierge

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MSC-TOPS-74

