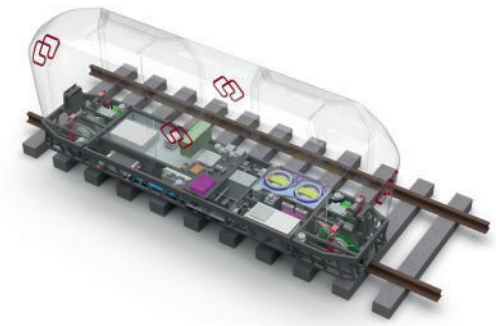
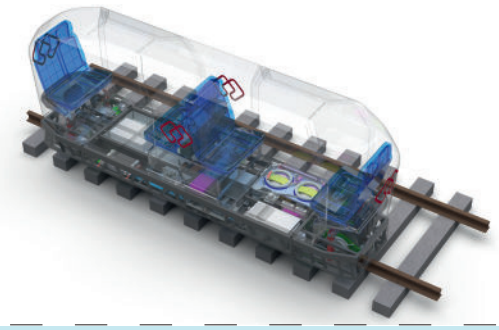
THE MONOCAB

Technical Leaflet – Project MONOCAB OWL OCTOBER. 2024
www.monocab-system.com

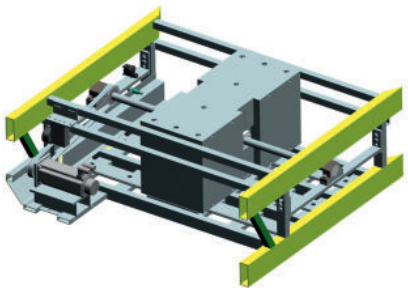
Abstract – The MONOCAB is a compact, autonomous monorail vehicle. In contrast to other so-called „monorail“ vehicles, it stabilizes itself on a single conventional rail without mechanical support. A narrow vehicle body allows a simultaneous operation in both directions on single-track lines. Therefore, MONOCABs can be used to implement very innovative rail-based mobility concepts with „service-on-de-mand“ as an attractive alternative to conventional solutions, especially for reactivating disused railway lines in rural areas.

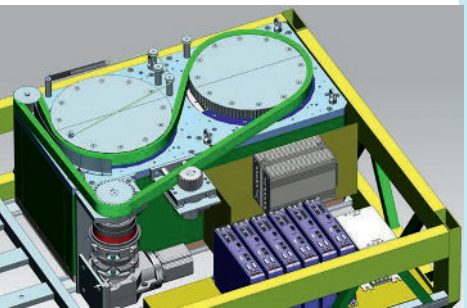




INTRODUCION

The MONOCAB project was initiated to develop an innovative vehicle concept for sustainable mobility in rural areas. Currently, there are fewattractive, effective, and ecologically or economically viable alternatives to private cars in sparsely populated regions. Reactivating disused railway lines is a sensible solution as the infrastructure already exists. Flexible rail-based mobility concepts with „on-demand“ services onthese lines could connect to transport hubs in medium-sized centers, forming the backbone of a future multimodal mobility system.





STABILISATION

The basic technical feasibility of monorail vehicles is out of question, since a first vehicle was already realized and successfully tested in 1906 by Louis Brennan, [1]. The vehicle‘s stabilization system [2] consists of two control moment gyroscopes, each weighing 250 kg, which rotate at 4800 revolutions per minute. These gyroscopes are implemented as a dual-gyro system with opposite rotational and precessional movements to prevent unwanted torques while driving through curved tracks. This is supplemented by a trim mass, approximately 600 kg, that can be shifted laterally.

While control moment gyroscopes are used to compensate transient disturbances (e.g. wind gusts, track irregulations), the trim mass is required to compensate stationary imbalances (e.g. uneven loading). The stabilization system requires a control device for compensating disturbances and achieving a desired inclined position in curves. The control uses an inertial measurement unit (IMU) sensor to estimate the roll angle of the vehicle. Such sensors can be also found in smartphones, drones, navigation systems, and wearable technology.

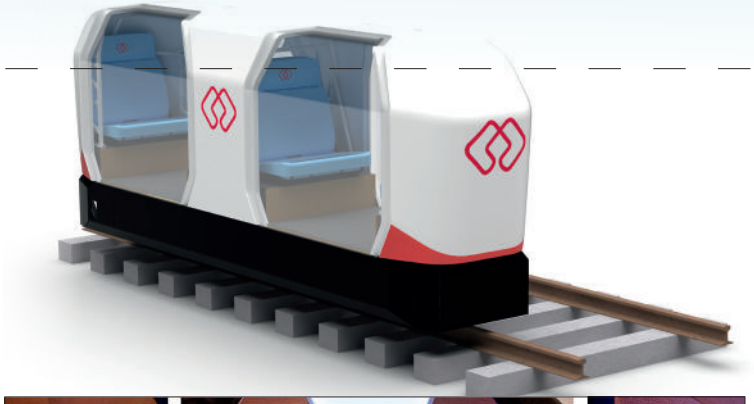
AUTONOMOUS OPERATION

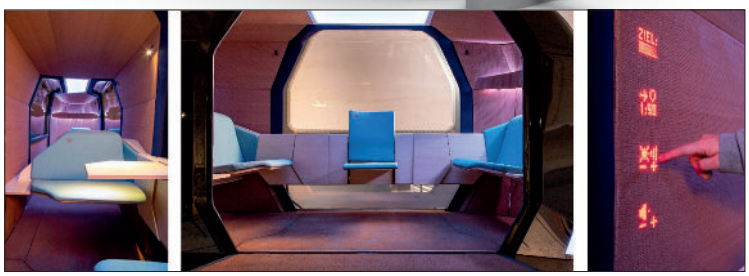
A core feature of the MONOCAB is its ability to operate autonomously without the need for human intervention. Automated Train Operation (ATO) is critical to ensuring the safe and efficient function of the MONOCAB, especially in scenarios where it must share tracks with other vehicles or operate in high-density environments, [3].

The MONOCAB's ATO system can detect other vehicles, respond to obstacles, and manage braking and acceleration without human input. Current research is focused on refining the fusion of radar and camera data to enhance the vehicle's situational awareness and ensure reliable operation even in challenging conditions.

The MONOCAB incorporates advanced environmental sensing systems, including radar and camera sensors, to support its fully autonomous driving capabilities. The detection system is built on machine learning models, which offers real-time object detection and recognition.

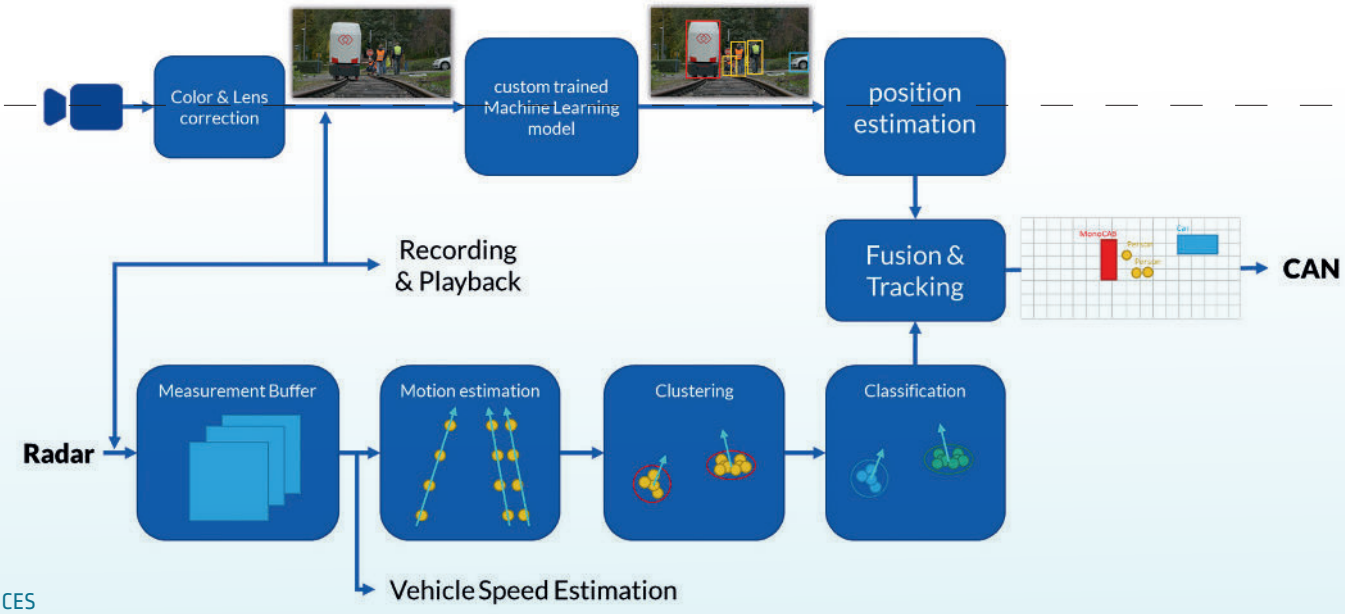
To ensure smooth and safe operations and efficient fleet management, the MONOCAB is equipped with a communication system for multiple purposes: Vehicle-to-Vehicle and Vehicle-to-Infrastructure communication, remote control from an external control centre and MONOCAB fleet management. In the current research, the 5G technology is investigated especially in the context of real-time capable communication [4].





VEHICLE DESIGN

The vehicle itself is compact and designed to fit within the constraints of single-track lines, where the standard distance between track centers is around 150 cm. MONOCABs have a width of 120 cm, with 50 cm extending inside the track and 70 cm outside, requiring careful balance to ensure the vehicle's stability. The MONOCAB also maintains a low center of gravity by placing heavy components such as the gyroscopes, trim mass, battery, and drive systems within a 40 cm high technical compartment beneath the passenger cabin. This design ensures that the vehicle remains balanced even at high speeds or when subjected to external forces like wind.



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[4] Bröring, Andre, et al. „A communication concept using 5G for the automated driving monorail vehicle MONOCAB." KOMMUNIKATION IN DER AUTOMATION (2023).

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