

1 Built-in drive modules with steering motor.

2 Omnidirectional mobile platform.

## COMPACT DRIVE MODULES FOR OMNIDIRECTIONAL ROBOT PLATFORMS

### Background

The near-term goal is for mobile robots to be increasingly used also in everyday environments. To be able to operate swiftly in confined spaces and to navigate safely to its destination, a mobile robot needs to be sufficiently manoeuvrable.

Most commercially available mobile platforms currently employ differential drives or three-wheel kinematics. However, these have the disadvantage that they do not allow a change of orientation during travel and no sideways travel.

Only the use of omnidirectional drives offers the required flexibility.

### Our solution

Fraunhofer IPA has developed a novel omnidirectional drive concept that combines the flexibility of standard wheels with the manoeuvrability of omnidirectional drives. These modular and compact two-axis units can be used for all robot applications from household robots to driverless transport systems.

### Motion characteristics

The use of two or more driven and simultaneously steered wheels offers some major advantages over conventional special-purpose wheels, such as Mecanum wheels. For example, there is the guarantee of safe forward travel also on slippery or loose surfaces. The large contact area with the floor allows high carrying capacities in combination with smooth, low-noise operation. In addition, the material and elasticity of the tyres can easily be adapted to suit the particular application.

### Fraunhofer Institute for Manufacturing Engineering and Automation IPA

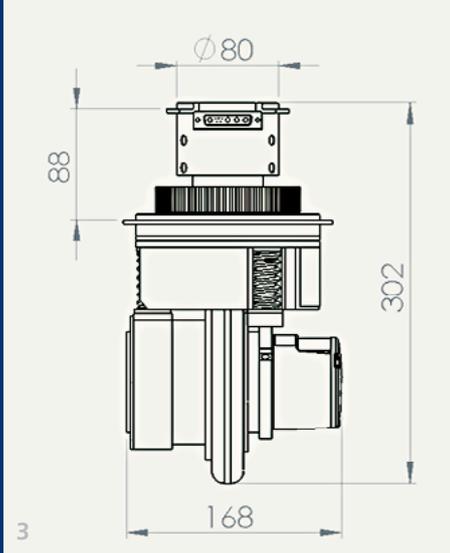
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### Construction of the drive

The key factors in the design of a compact mobile platform are the height (measured from the floor) of the two-axis module and the space required for a complete rotation about the vertical axis. To achieve good values on both of these fronts, the platform employs a hub drive with integral gear unit. The drive unites motor, resolver, brake and planetary gear set inside a single housing. Power is transmitted to a tyre centrally arranged on the shaft. The controller for the direct servo drive and the electronics for activation of the brake are integrated into the stem of the two-axis module, which makes for an even more compact design.

The power supply connections (48 V power and logic voltage) as well as the CAN bus interface are brought out through the top of the two-axis module by means of a rotary connector. This allows any desired steering motions to be executed without the fear of twisted cables. The drive module is steered by an external servo motor. Power is transmitted by a belt on the stem of the module.

Another special feature of the drive module is its integral suspension, which, while protecting both the controller electronics inside the stem and also the entire body of the robot against shocks and impacts, also provides for improved contact between tyre and floor.

### Performance data

A single drive module is suitable for a carrying capacity of between 40 kg and 65 kg. For integration into a compact, omnidirectional robot platform, the four two-axis modules are made as compact as possible while still delivering the required power to drive the platform.

The drive motors have a gear ratio of 21, with a maximum torque of 40 Nm. This makes it possible to achieve speeds of up to 1.5 m/s. The steering drives have a maximum torque of 9 Nm.

### Modularity and scalability

Thanks to their modular construction, these compact two-axis units allow the design of any desired omnidirectional platform according to the unitized construction principle. The choice of a different gearing makes it possible to adapt the ratio between speed and torque to suit the particular application. If necessary, it is also possible, of course, to employ a more powerful drive motor in the wheel hub.

### Reference projects

#### Rehabilitation robot

The goal of this project was to develop a mobile rehabilitation robot with which to enable, for example, stroke patients to learn to walk again. The robot follows behind the

patient and supports them if they lose their balance. The use of omnidirectional drive modules allows the robot to adapt ideally to the patient's movements.

#### Care-O-bot® 3

Care-O-bot® 3 is a prototype service robot for assisting humans in a domestic environment. To enable it to move safely also in confined spaces, the robot is equipped with omnidirectional drives.

#### rob@work 3

rob@work 3 was designed as a versatile assistance robot for production environments. Its flexible, omnidirectional platform makes it ideally suited to a variety of different working environments.

### What we offer

Fraunhofer IPA will help you to design and construct customized two-axis modules or complete omnidirectional mobile robots to meet your exact needs:

- Customized analysis of requirements, consulting services and application planning.
- Design and configuration of suitable two-axis modules.
- Application-specific equipping of mobile robots with the required drive modules.

- 3 Installation dimensions of a drive module.
- 4 rob@work 3 assistance robot.
- 5 Care-O-bot® 3 household assistant.