DFKI INDUSTRIALS GmbH

Fact Sheet TIV-A-X

The TIV-A-X rover

The TIV-A-X (terrestrial intervention vehicle – autonomous) is a highly mobile rover, using a triple bogie suspension and rubber tweels. It comes with powerful sensors, has an impressive payload and can be equipped with an optional manipulator arm. TIV-A-X rover is equipped with high internal processing power (Quadcore i7) and a reliable wireless communication (802.11ac).

By using a triple-bogie suspension and powerful drive motors and rubber tweels for each of the six wheels the system is highly mobile and can overcome slopes up to 40°.

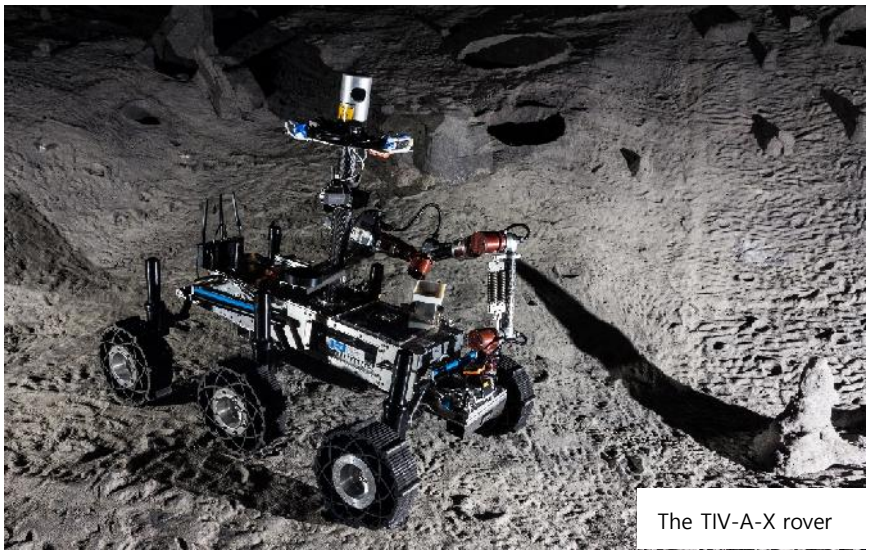
Size	120 x 80 x 107 cm
Weight	75kg
Payload	10 kg for optional sensors or other equipment
Power Supply	8 Ah at 48 V / 355 Wh (Lithium Polymer)
Speed and range	0.5 m/sec / range 2 km
Actuation	12 x 48V RoboDrive BLDC motors / Harmonic Drive gears for the wheel hub drives; 6 x 48V Faulhaber BLDC motors / Harmonic Drive gears for the steering shafts; 3 x Dynamixel MX-28 for the manipulator and the laser scanner tilt units
Sensors (built in)	Velodyne HDL-32E, Hokuyo UTM-30LX, Logitech Webcam C910, Prosilica GX, IMU Xsens MTi-28A53G35
Communication	Asus RT-AC66U Dual Band 3 x 3 802.11ac Gigabit Router
On board PC	Kontron KTQM77/mITX i7 Quadcore
Manipulator (optional)	6-DOF manipulator arm, with 2-DOF two finger gripper. Max. payload 1kg 2 x Dynamixel MX-28 servos for the manipulator 6 x 48V RoboDrive BLDC motors / Harmonic Drive gears

Rich sensor suite

In addition the system contains a Hokuyo to create a dense point cloud of the front area of the system, four cameras for the visual exploration of the environment and a Velodyne laser scanner. This Velodyne has a measurement distance of up to 80m and is used to create a detailed map of the surrounding of the rover.

The rover is capable of creating accurate maps of its environment and to estimate its pose precisely by using a Graph SLAM which has been optimized for the high-performance Velodyne HDL-32E laser scanner.

The Hokuyo laser scanner which has been mounted beside the manipulator arm is used to scan the front area of the rover and to gather dense point clouds for object detection.



The TIV-A-X rover

The Logitech cameras which are placed on the central sensor tower and in the front chassis are used to:

- support the operator with a 360° view of the environment
- execute a color- and gradient-based object detection
- support manipulation tasks

Manipulator arm

The equipped manipulator arm has six degree of freedom and has been designed to manipulate objects with a weight of up to one kilogram. The motors are brushless DC motors with harmonic drives, which result in a high stiffness of the arm. The links are made of carbon fiber to in order to optimize the total mass of the arm. The arm can reach both in front of the robot, as well as structures on the robot itself. In this way objects can be placed on the body of the rover. The gripper element has two degrees of freedom, and allows both flat and rounded grip types.

The TIV-A-X rover in action

Software

The software of the rover includes all the drivers for the sensors and actuators. This allows a custom configuration of the robots behavior. The base system is also equipped with higher level modules for navigation and manipulation.

For navigation, the system includes a control stack, which controls the wheel angles and rotational speeds, to produce directional movement of the system. Further, a path planning module allows the system to find a valid path through a map, and control the execution of that path. Maps can also be generated on board using the SLAM (Simultaneous Localisation and Mapping) module. This module integrates different sensor readings and creates a 3D map of the surrounding, which can also be used for path planning. An exploration module combines the navigation capabilities, and allows the exploration and mapping of unknown terrain.

The software for manipulation allows the system to deploy the arm from the stowage position, and calculate the trajectory for moving the arm into a position for object manipulation. The execution of such a trajectory is also monitored. The gripper module uses the current readings of the motors to detect if an object has been successfully handled.