3.5 'Introduction of SherpaTT – Adaptive Suspension and Locomotion Coordinate Systems' (LM-P-01)

Florian Cordes [1]

(1) Robotics Innovation Center, DFKI GmbH, Robert-Hooke-Straße 1, 28359 Bremen, Germany

Contact: florian.cordes@dfki.de

Abstract

The poster presents the hybrid wheeled-leg rover SherpaTT, which is the successor of the rover Sherpa. The rover in its integration state as of September 2015 is presented and the main specifications of the system are provided. SherpaTT has in the current integration status a weight of approximately 115 kg and a square shaped foot print of roughly 1 m×1 m in its standard pose. Definitions of the three standard poses that maximize the motion range for adaptive processes are given. Furthermore, the main coordinate systems used for different tasks in the locomotion control are described.

Deutsches Forschungszentrum für Künstliche Intelligenz GmbH

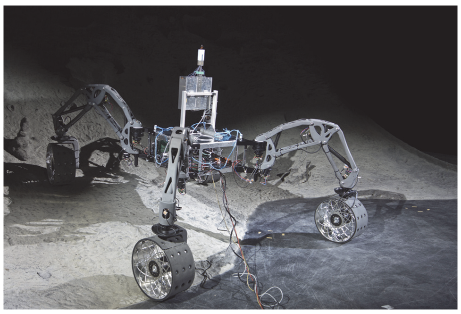
Introduction of SherpaTT

Adaptive Suspension and Locomotion Coordinate Systems

Florian Cordes

System Overview

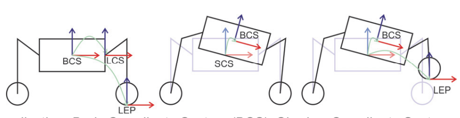
SherpaTT is a reconfigurable and versatile hybrid wheeled-leg robot. It features an active suspension system with four legs, each ending in a drivable and steerable wheel.
Three degrees of freedom (DoF) of each suspension unit are used for moving the leg end point (LEP) in the space around the robot. Two DoF are used for orienting and driving a wheel.



Photograph of integration study of SherpaTT without manipulator arm

SherpaTT Specification

- Weight: 115kg (without manipulator)
- Dimensions of footprint:
  - Min (stow position): 0.9m x 0.9m
  - Max: 2.2m x 2.2m
- Degrees of freedom:
  - Legs: 5 active DoF, planned is a 6th (passive) DoF by introducing flexible wheels for passive ground adaption
  - Arm: 6 active DoF
- On-board sensors:
  - Legs: Joint position (absolute and relative), speed, current consumption, supply voltage, and 4 x 6 degree of freedom force/torque sensor,
  - Body: Inertial Measurement Unit, battery voltage monitoring
  - Planned for navigation: Hokuyo UST-20LX + Basler Ace 25fps camera and a Velodyne rotating lidar.
- Power supply:
  - 44,4V / 10.0Ah (lithium polymer)
- Run-time:
  - approx: 150min
- Driving speed:
  - Currently limited to 0.16m/s
- Computational power:
  - Intel Core i7 Processor with 4x 2.2GHz (up to 3.20 GHz)

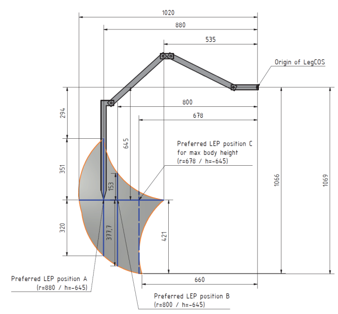


Visualization: Body Coordinate System (BCS), Shadow Coordinate System (SCS), Leg Coordinate System (LCS) and Leg End Point (LEP)

Movement Possibilities due to Active Suspension System

Using the active suspension it is possible to:
- Move single LEPs to conform to the terrain
- Coordinated movement of all LEPs to change the body's attitude
- Combine both possibilities to independently control the robot's attitude while driving in rough terrain

The Movement range of the LEPs is a complex shape due to the two serially linked parallel structures in a leg. It has a maximum extension of about 770mm in height and 500mm in length. The volume of the movement range is spanned by rotating around the first joint of a leg (in total: 215°).



Range of motion of one leg in cut view (mock-up leg for dimensions is shown).

Locomotion Coordinate Systems (CS)

Different CS are needed for the realization of the full reconfiguration capabilities of the robot. The following CS are currently being used.

- Shadow Coordinate System (SCS)
  - Used for locomotion commands (i.e. forward, lateral and point turn)
  - Used for commanding the Body Posture
  - Transformation between SCS and BCS is the body posture
  - Coincides with BCS if BP = 0
    - BP defines: roll, pitch, yaw as well as x-lean, y-lean and body height
- Body Coordinate System (BCS)
  - Attached to the center of the robot body
  - Used for all internal kinematic calculations
- Shadow Leg Coordinate System (SLCS)
  - Used for manual foot print commands
  - Subset of SCS for convenience: Give LEP commands in cylindrical coordinates
- Leg Coordinate System (LCS)
  - Attached to body
  - Used in inverse kinematics

Universität Bremen

Gefördert durch:
DLR

Kontakt:
DFKI Bremen & Universität Bremen
Robotics Innovation Center

Direktor: Prof. Dr. Frank Kirchner
E-Mail: robotik@dfki.de
Internet: www.dfki.de/robotik