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Autonomous Unmanned Ground Vehicle as Sensor Carrier for Agricultural Survey Tasks

For agricultural surveys, the use of unmanned ground vehicles (UGV) as sensor carriers is becoming increasingly attractive. These vehicles can be equipped with multiple sensors to achieve a high level of autonomy and to improve productivity and profitability in agricultural environments. This poster illustrates the design and construction of a newly build UGV and presents prerequisites for a hard real-time controlled sensor platform on top of the UGV.

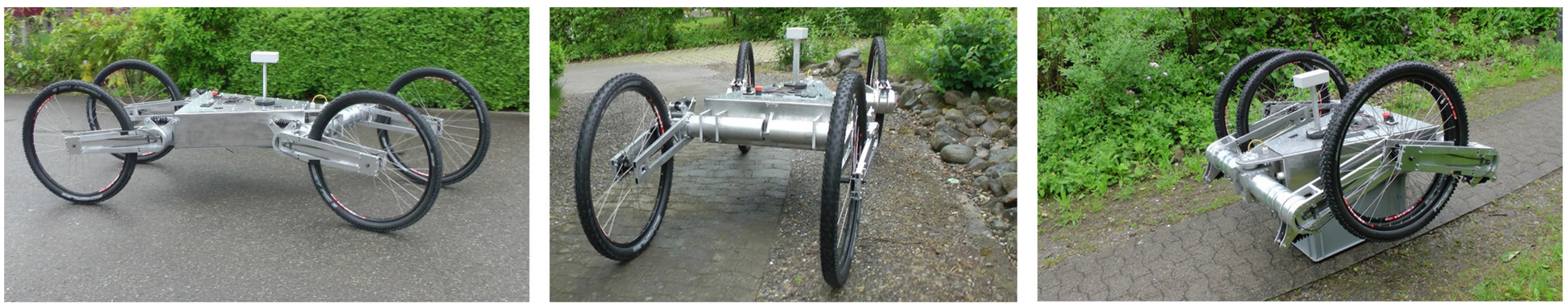

Figure 1 - Left: The ZHAW sensor platform with 29-inch wheels, side view. Central box and wheel suspensions are constructed from aluminium, which results in a 65kg light weight vehicle. - Center: UGV rear view with minimum axle width. - Right: The UGV folded for transport (1050 x 1250 x 770mm) can be handled by two persons without the need of a crane.

The UGV

A requirement on the UGV as sensor carrier platform is to enable driving through a crop under harsh environmental conditions over rough and skewed ground. Thus the ground clearance was set to 450mm and an adjustable wheel distance between 0.8 and 1.2m was constructed. The electric motors and gears are integrated in the tubular telescopic legs (see Figure 1). The wheel axles are driven by chain drives. This drivetrain design can accommodate track width and height changes. A hinged axle enables a small turning radius for the transfer from one leg of the survey to the next. The intended payload for sensor equipment amounts to 50kg.

Hard real-time controlled sensor platform

The UGV will be equipped with an advanced sensor platform consisting of stereo vision and LIDAR for environmental modelling (Figure 2) as well as an IMU, odometry, compass and GPS sensor for autonomous navigation and drive control. The positioning of sensors shall be variable to provide high flexibility for different field applications. To increase profitability of UGVs for farming, the robot shall follow plant rows in an autonomous manner. To obtain high robustness and reliability for drive and sensor control a hard real-time control system is envisaged, as provided by Beckhoff Automation. The software components will be implemented in order to be scalable, reusable and portable to all Beckhoff computer platforms. The final goal is to design, assemble and test UGVs for data acquisition without tedious and error prone ‘start(s) from scratch’. The use of industrial-level automation components will enable rapid hard- and software development and allow more efficient research focusing on the issue and not on marginal problems, such as control system selection and integration.

Figure 2 - Measurement head of sensor carrier with stereo cameras and LIDAR, GPS antenna is not depicted (developed in project 3D-Mosaic).

Experiments and challenges

The sensor equipment carried by the UGV requires suspension and damping. As past project 3D Mosaic has shown, stable driving characteristics of the vehicle are required to ensure reasonable data acquisition (low noise, no image blur). A compact storage arrangement simplifies UGV handling between different spots. Furthermore low friction with the ground for minimal disturbance to the crop is desired by future users. First tests with the UGV presented show stable steering characteristics and sufficient power for up-hill motion. The arrangement of a sensor head with multiple sensors for environmental modelling and navigation, as well as the realisation of a hard real-time control system for the drivetrain and sensors results in this concept study being a very challenging task.

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