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MRVK v3

HW & SW description

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Introduction

MRVK v3 is the third major conceptual reconstruction of the Mobile Robot Vehicle Kit platform, constructed by the ZŤS VVÚ Košice company in 2009. It is a 4-wheeled, skid-drive robot, designed to handle operation in outdoor rugged terrain. From the original assembly, only the chassis and the powertrain remained. Power supply system, computing units, sensors as well as software stack are part of the current redesign.

Figure 1: MRVK robot (original version)

1 Powertrain and Power Supply

The vehicle's powertrain system consists of two motors Baumuller GDM100N2 330/0710, each one connected to a two-speed gearbox. The gear ratio can be changed between three modes: 1:1, 1:2 and neutral. Afterwards, the torque is transmitted to each wheel through the SPINEA planetary gearbox with fixed ratio (see Figure 2).

The motors are controlled by the MD03 H-bridge drivers with output voltage of 24 V and maximum power of 250W each. In relation to these parameters, we chose a 6S1P LiPo battery as the primary power supply of the robot. Though, for developing purposes, it can be powered directly with an external power supply. Computational and sensory part of the robot is powered by an industry-standard MEAN WELL 24 to 12 V DC/DC converter. Overview of the hardware and power supply scheme can be found in the Figure 3.

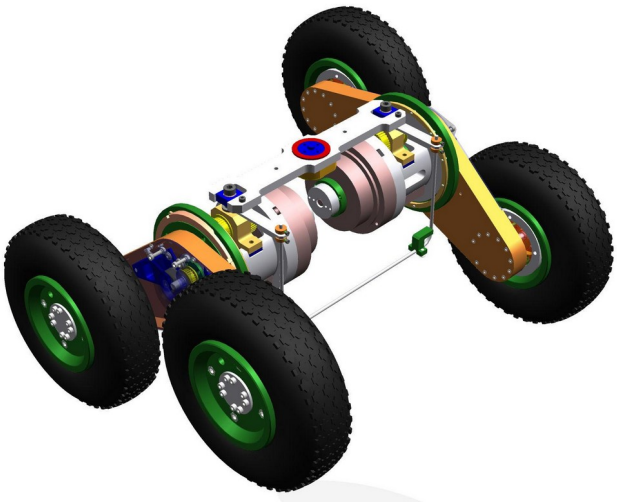

Figure 2: Powertrain system assembly

To allow for safe and controllable operation of the emergency button, a custom power distribution PCB was designed. Its main responsibility is to open the motor's power circuit immediately after the button was pressed and to signalize this state for the computing unit at the same time. This feature enables software reaction to an emergency situation invoked by an external operator.

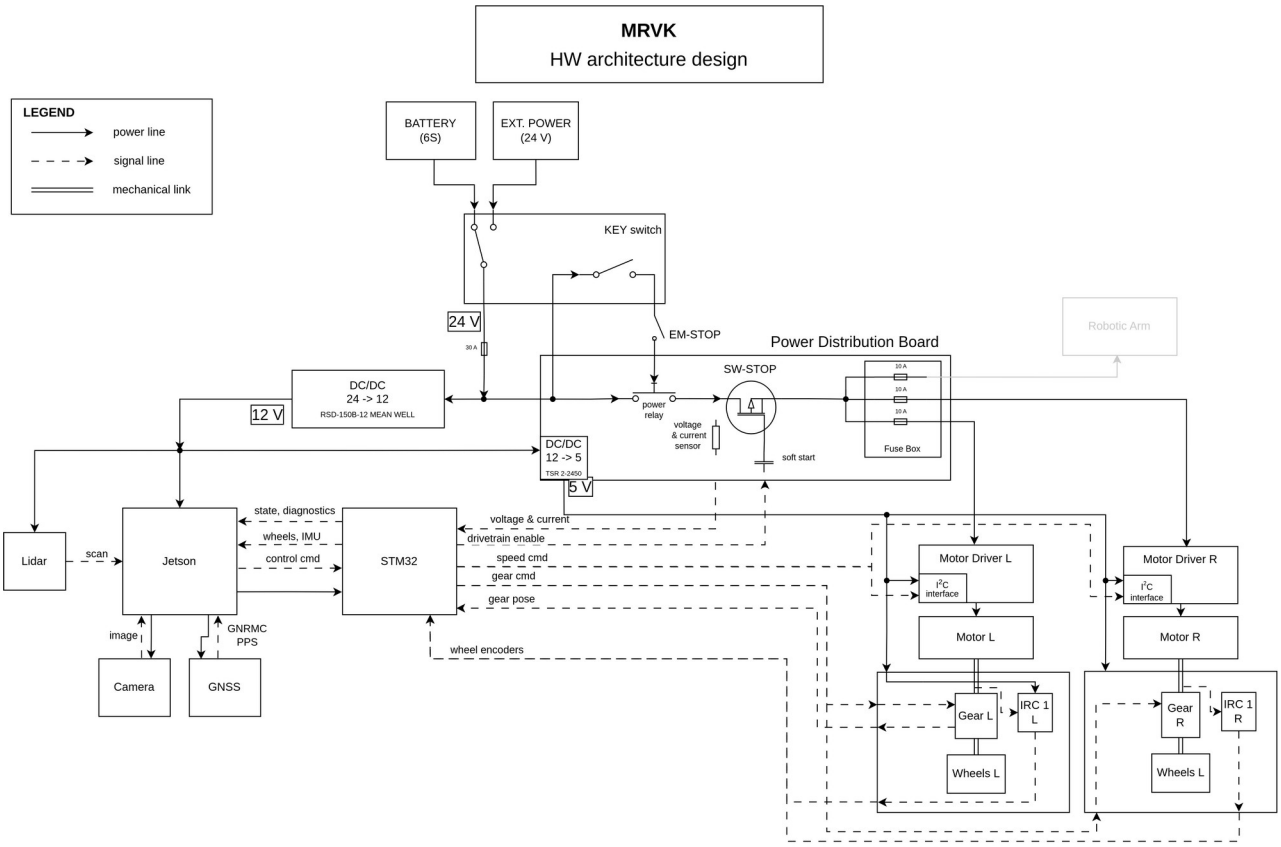

Figure 3: Conceptual scheme of HW architecture

2 Sensors

Perception of the robot is delivered by a Basler Ace 2 PRO camera and a Livox Horizon LiDAR with integrated IMU sensor (see Figure 3). The LiDAR data is used mainly for odometry and obstacle detection. In fusion with the camera image we use it for the terrain segmentation as well.

In order to get global position reference, we utilize the u-blox ZED F9 GNSS receiver. Thanks to a sponsored license from the SKPOS organization, we are able to get RTK corrections for maximum position precision.

Figure 4: Livox Horizon LiDAR (left) and Basler Ace 2 PRO camera (right)

3 Computing units

Computational tasks are divided into two units. Low-level control is managed by STM32 Nucleo developer's kit SBC. It provides a control interface for motor drivers via I^2C bus, including the sending of PWM modulation values and receiving wheel odometry from encoders, useful for speed control. It also provides access to the voltage and current measurements on the power distribution board.

Figure 5: Nvidia Jetson Orin 64GB devkit

The main computing power is cumulated in the Nvidia Jetson Orin NX computer, running the high-level software stack. It is connected to the SBC via USB (ST-Link) providing power

supply and serial communication interface. In the similar way it is connected to the camera and GNSS receiver. The connection with the LiDAR is provided by Ethernet interface.

4 Software

The software stack is based on ROS2 Humble framework. It consists of several modules, however the structure is still subject of development, testing and tuning process with focus on reliability and long-term stability. To maximize development efficiency, we utilize many of the well-established open-source solutions, such as FAST-LIVO2 for odometry and SLAM, Segformer for terrain segmentation or Nav2 for navigation and behavior control.