HUSARION

Panther

power consumption and run time

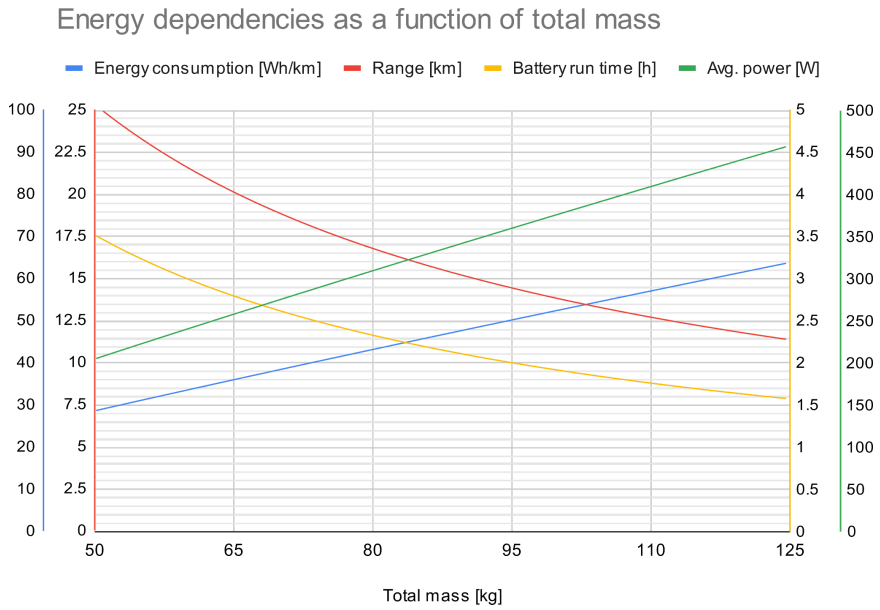
Introduction

A standard version of the Panther robot has a battery with an energy capacity of 720 Watt hours. Under average conditions, this allows for around 8.5 hours of work. Later in this article, we will explain exactly what these conditions are and how the working time changes depending on the working conditions of the robot. Before publishing this document, we conducted numerous field tests with various uses of a robot. Therefore, the presented results are not laboratory and mathematical estimates, but a real-life example of the robots performance.

The tests were carried out on a robot with WH01 wheels, tire pressure of 17 psi, and the weight of the robot of 54,3kg.

Weight

One of the factors significantly influencing the working time of the robot is the weight that the robot has to move. So if we add an additional payload to the weight of the robot (about 54 kg), the robot moving straight on a concrete floor, with a constant speed of 2 m/s, will increase its energy demand, and thus shorten the maximum working time, as presented in the diagram below.



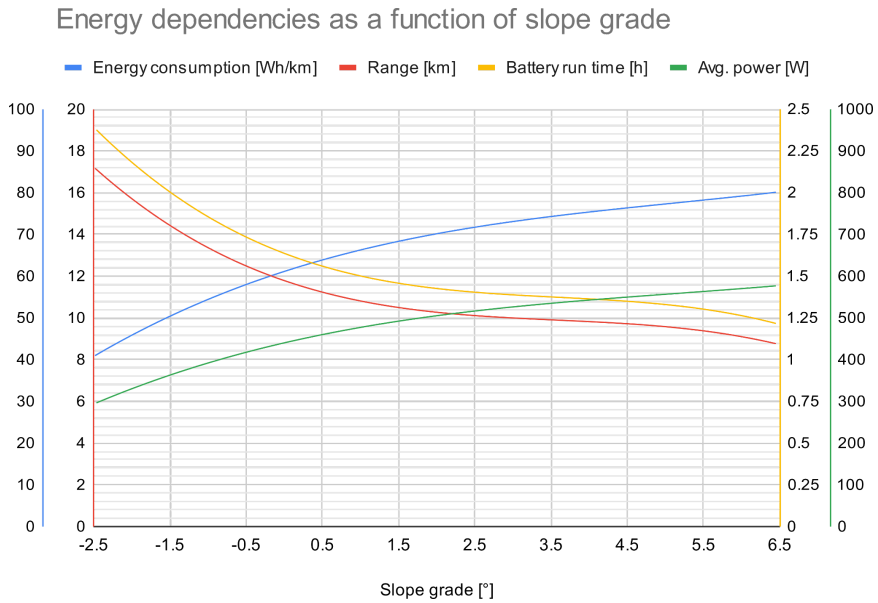
At: 2m/s run, concrete horizontal paving.

Kraków, July 2021

Note: A Panther carrying another Panther on top of it (double weight) will travel 13km at maximum speed, using the entire capacity of the battery during this time.

Slope grade

Another factor which may be significant for shortening, as well as extending the working time of the robot, is the slope of the terrain. The collected data is presented below.

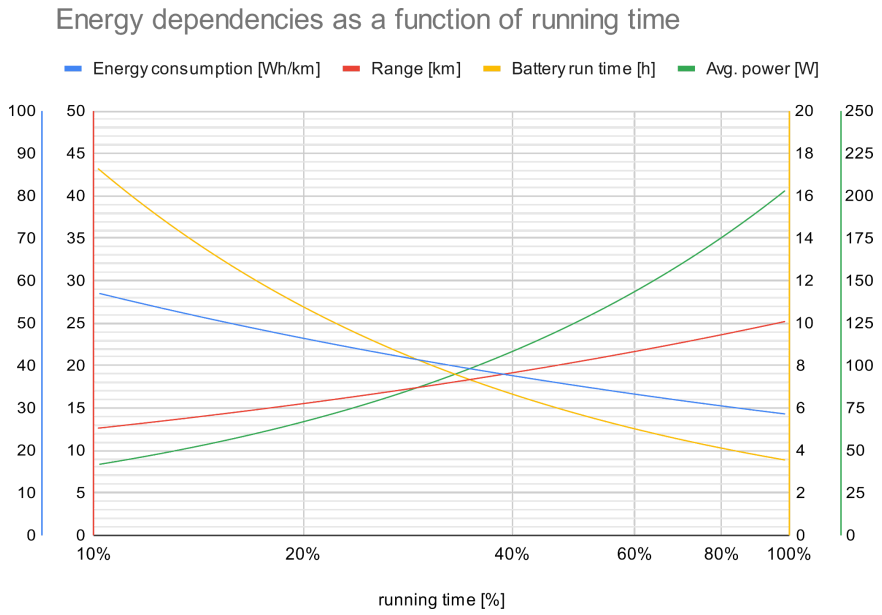


At: 119,3kg of total mass, concrete paving.

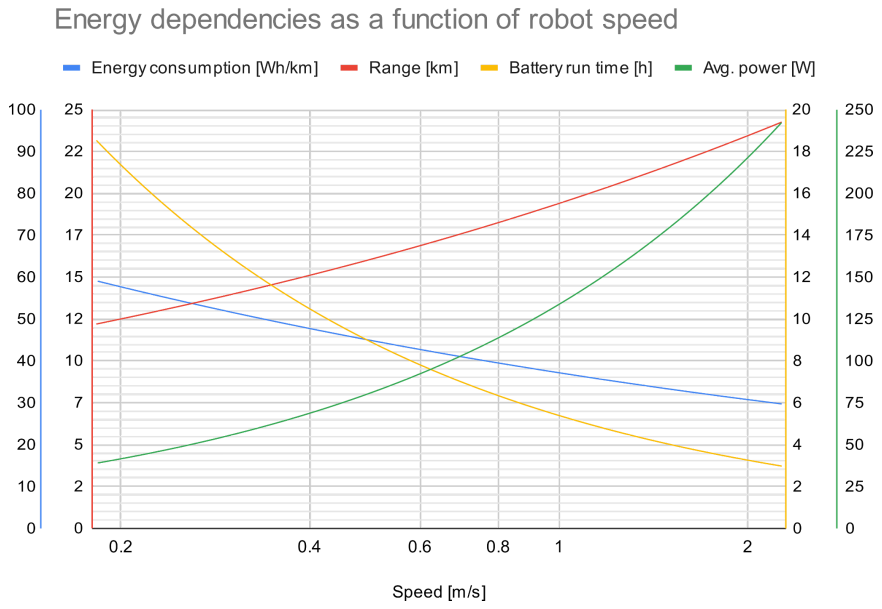
Note: The robot, driving on a road with a slope of 6.5 °, can lift a payload of 65 kg to a height of 905 m in just over one hour. On this route, it would take a person walking with a 12 kg backpack about 3.5 hours.

Reducing the average speed of the robot

There are also situations which could potentially increase the robot's working time and at the same time reduce its maximum range. These include a reduction in the speed of the robot's movement and the occurrence of downtimes (idle states) in the robot's work.



At: 54,3kg, at 2m/s, concrete paving

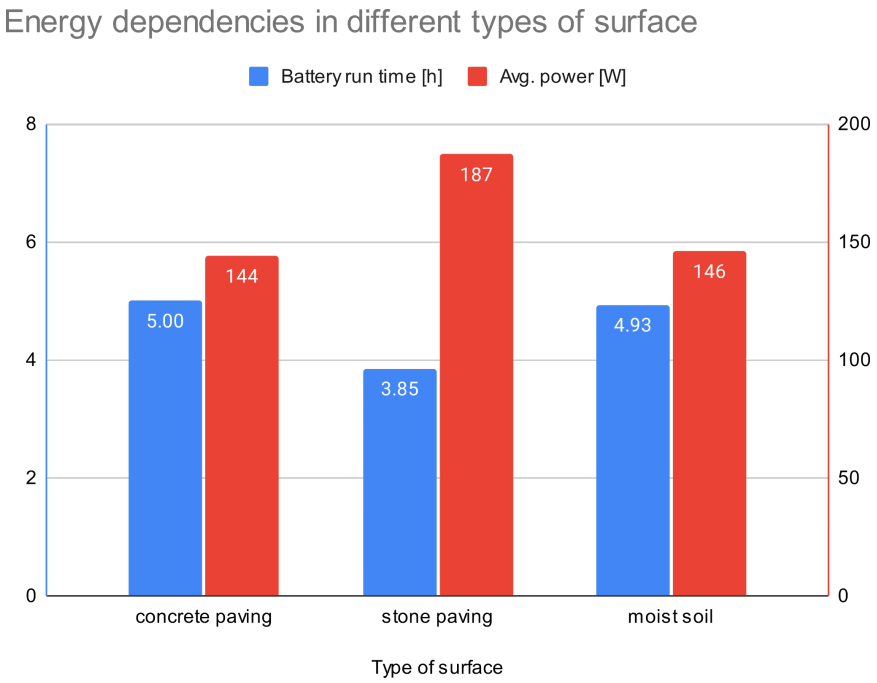


At: 54,3kg of total mass, concrete paving.

Note: Reducing the range of the robot in the above situations takes place by increasing the energy share of computing units on board the robot. However, sometimes even more computing power is required to support a high-speed robot. Therefore, the exact determination of the working time and the maximum range of the robot must be tested on a specific set of sensors, software and even the terrain, but these fluctuations will not significantly differ from the data given in this chapter.

Types of surfaces

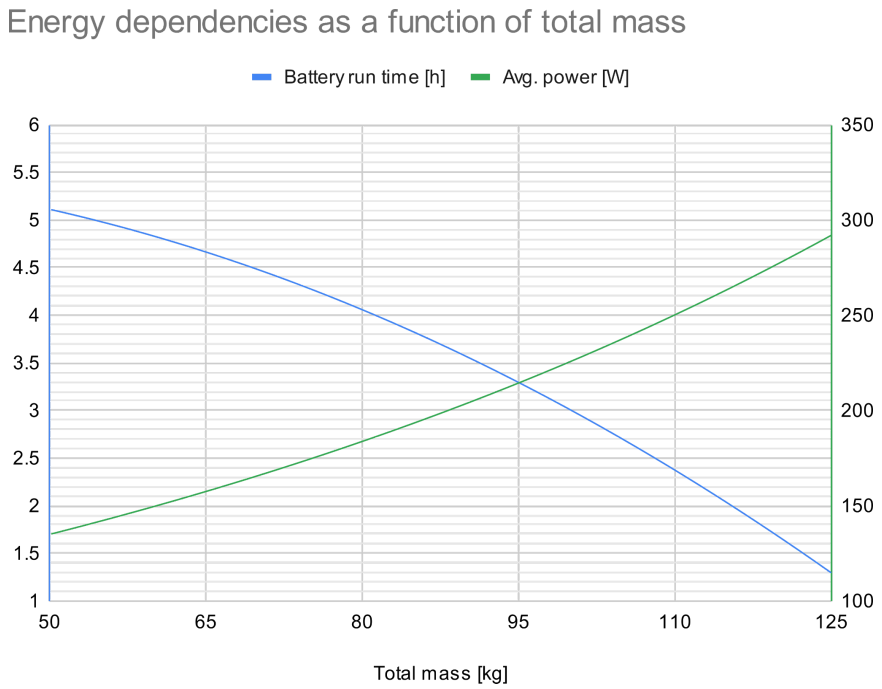
The type of surface also has an impact on the energy requirements of the robot while it is in motion. A more muddy terrain will require more energy by reducing the performance of the tires on the road when driving straight. However, reducing the friction force makes turning on the spot easier. Data on these differences were collected during the rotational movement around the vertical axis (spinning).



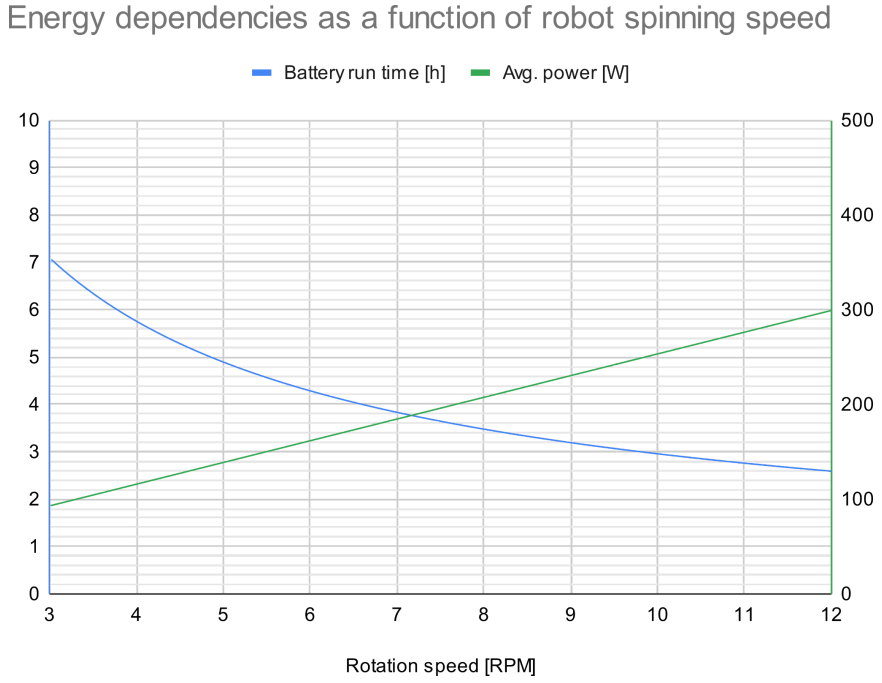
At: 54,3kg, about 4.5RPM.

Spinning

Rotation in place of a four-wheel robot with a differential drive may require a lot of power, so it is important to take into account the energy needed, depending on parameters such as the weight of the robot or rotation speed - the relationships are shown in the graphs below.



At: at 5 rpm spinning, concrete paving.



At: 54,3kg of total mass, concrete paving.

Summary

Our experience of using the robot in various use-cases shows that the average power of the robot in mixed motion, i.e. along a curvilinear path, with maximum speed, does not exceed 280W. In most of the tasks, the robot moved about 25% of the time. In such a case, the robot operated for 8.5 hours on the initially fully charged battery, covering the distance of 15 km during this time.