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Optical-chemistry experiment measuring gases by the HUSAR-5 NXT-based rover model

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Abstract

The Széchenyi István Gimnázium High School built a new chemistry experiment to the HUSAR-5 rover model. The rover uses optical lens as classical heating experiment and uses gas-sensors in measuring the chemical components liberated by the heating. This experiment gives a new style to measure the characteristics of the soil on the surface of a planet.

1. Introduction

HUSAR-5 (**H**ungarian **U**niversity **S**urface **A**nalyser **R**over) is a rover model built in a Hungarian high school by students. They use LEGO-elements and NXT (a programmable "brain") on a field-rovering car model.

2. The task of the mission and the construction of the rover

The main goal of the measuring experiment was to move and fix the lens so that the plane of the lens should be perpendicular to the axis of the incident solar light. It is also task that the focus of the lens should reach the soil exactly. This should be operated at any incidence position. We solved this problem by using 3 motors. 2 motors moves the lens around horizontal axes, and the third one around a vertical one. The technological structure of the Husar-5 instruments has been built from LEGO elements, driven by LEGO Mindstorms motors and controlled by the NXT "brain". Although the set contains a lightsensor, but it was too heavy for this experiment, therefore we used a light one photoresistor, and the signal of it was introduced into the NXT.

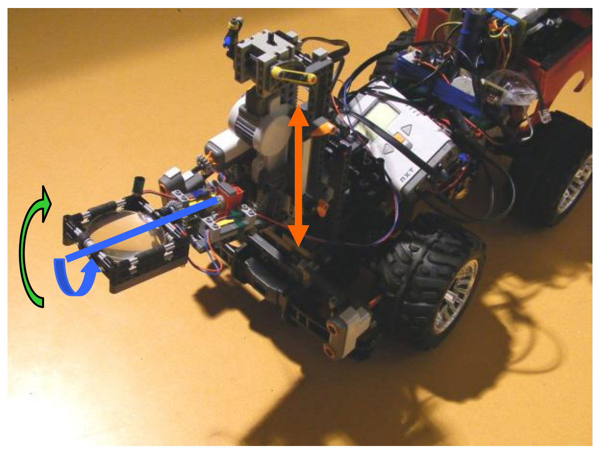

Figure 1. The movement of the three arms

3. The steps of the measuring process

3.1 Focusing

1. Basic position: The lens is in resting position exactly a focus distance above the soil. The holding arm is horizontal, the plane of the lens is also horizontal, parallel with the soil.

2. The lightsensor measures the intensity of the light and the program decides, is it enough to begin the measurements.

3. After selecting the location of the measurement, the computer program first moves the lens and finds the position (by the help of the lightsensor) where the intensity of the light is the largest. This is a β angle with the horizontal plane.

4. The other motor moves the arm up and down and position the lens plane perpendicular to the solar lights. The program takes into the memory the measured α angles.

5. Lifting up the arm is the next step. The H height where the lens collects the sunlight exactly at the focus of the lens reaching the soil surface:
$H = h \cdot \cos \beta$ where $h = f \cdot \cos \alpha$ (see Fig. 2.).

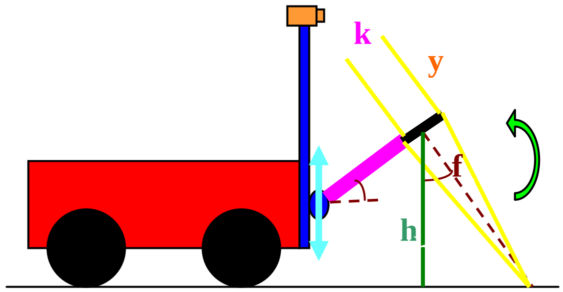

Figure 2

From the initial position the lifting motor states the arm to the necessary position. After lifting the centrum of the lens is in the height of $y = f + k \cdot \sin \alpha$ so it is needed that the movement of the arm should be y – h distance. (Using the speed of the movement the program calculates the time of the motion.) This way the focusing was varied out. By the effect of the solar rays gases are liberating from the soil.

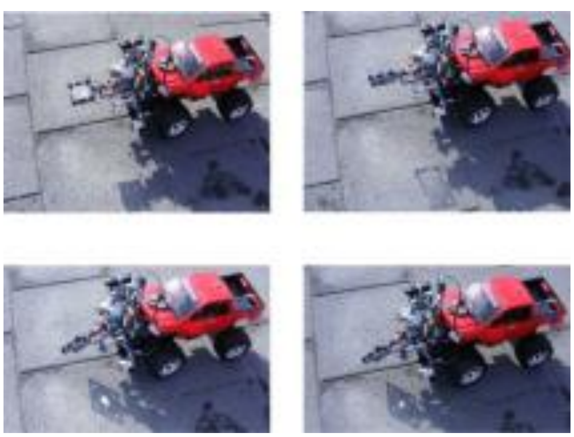
Figure 3: the steps of focusing

3.2 Detecting gases

We use CZGCO type CO sensor for the detection of the liberated carbon monoxide. We placed this sensor into the frame of the lens. This is a semiconductor based sensor, that is heated up to the working temperature of ca. 400 °C. The measured gas is measured as a resistance change signal introduced into the NXT. The measured values are observed on the screen of the NXT and also on the screen of the "terrestrial control" computer. (There is Bluetooth based communication between them).

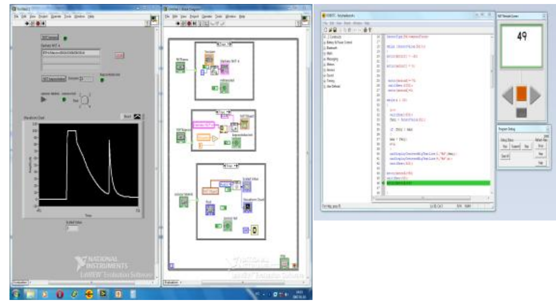
Figure 4: Programs in Labview and RobotC

There are two possible ways of observing the events on a distant computer: Eighter visually demonstrating the changes in the resistance in the gas sensor, therefore proving the presence of the gas, or visualizing the rate written on the NXT screen. All while being able to trace the running of the program.

4. Further developments:

The gas-sensor at this moment is fixed. But sometime the focused beam is left or right from the rover, it lays not front of the sensor. We planned a motor for the gas-sensor too. It could move the sensor and it would follow the light beam.

We consider the soil surface as horizontal. The measuring place can be selected by the "terrestrial control". They observe the environment through the camera on the top of the tower on the Husar-5. We also plan an instrument for planaring the soil before the rover.

Acknowledgements

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References

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