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Chemical Experiments Measuring ph and Gases on "Planetary" Soil by the HUSAR-5 NXT-based Rover Model

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Introduction: We report two chemical experiments studying the soil on the surface of a planet. Both experiments are built on the HUSAR-5 rover model (Hungarian University Surface Analyser Rover) in a Hungarian high school. In the first experiment our rover uses optical lens as classical heating experiment and gas-sensor to measure the chemical components liberated by the heating. In the second experiment we measure chemical characteristics of the soil by using the indicator method. We report the constructions and experiments carried out by our rover.

The task of the first mission: The main goal of the experiment is 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 important that the focus of the lens should reach the soil exactly, and it should be operated at any incidence position. We solved this problem using three motors. Two move the lens around horizontal axes, and the third one around a vertical one. The technological structure of HUSAR-5 instruments has been built from LEGO elements, driven by LEGO Mindstorms motors and controlled by NXT “brain”. We used a photoresistor, whose signal was lead into the NXT.
The steps of the measuring process are the followings
I. For focusing:
1. Basic position: The lens is in resting position exactly a focus distance above the soil. The holding arm is horizontal, and the plane of the lens is also horizontal, parallel to the soil.
2. After selecting the location of the measurement, the NXT first moves the lens and finds the position (with the help of the lightsensor) where the intensity of the light is the largest.
3. The other motor moves the arm up and down and positions the lens plane perpendicular to the solar lights. The program takes into the memory both measured angles.
4. The forth step is lifting up the arm into the necessary position. From the initial position the lifting motor states the arm to this position which is calculated by the program.
II: For detecting the gases:
We use CZGCO type gas-sensor for the detection of the liberated carbon monoxide or methane. This is a semiconductor based sensor which is heated up to working temperature (ca. 400 °C). The gas is measured as a resistance change signal lead into the NXT. The measured values are observed on the NXT as well as on the “terrestrial control” computer.

Construction of the rover in the second mission: the skeleton of the rover was a field-rovering car model. We constructed two arms and a pump from LEGO elements. On the first arm we placed a wireless camera, which could rotate 360°, and also could bend down. The role of the second arm was to stretch and place the indicator ribbon to the surface and move it along a distance to contact with the wet soil. The role of the pump was to pour water on the soil surface. The main idea behind our solution is that water dissolves important chemical components from the soil and the indicator ribbon reports the main chemical characteristics of this chemistry, starting with the pH of the soil.

Conclusion: Even the basic experiments can be interesting in the high school’s chemistry teaching process if everyday materials are studied. It can be easily connected to planetary surface chemistry, where the soil, the rocks and the atmospheric gases form a common platform with their counterparts on the Earth. Both the ex-

periment and the rover building was a big task for high school students, but they enjoyed the work and learned a lot.