PLANETARY ROVER ROBOTICS EXPERIMENT IN EDUCATION: HUSAR-5, THE NXT-BASED ROVER MODEL FOR MEASURING THE PLANETARY SURFACE Lang Á.[1], Szalay K.[1], Kocsis Á,.[1], Prajczer P.[1], Bérczi Sz.[2], [1]Széchenyi István Gimnázium High School, H-9400 Sopron, Templom u. 26. Hungary (mmecurie95@gmail.com) [2]Eötvös University, Institute of Physics, Dept. Materials Physics, H-1117, Budapest, Pázmány Péter s. 1/a. Hungary (bercziszani@ludens.elte.hu)

Introduction: We report about the work of the HUSAR-5 Groups from the Széchenyi István Gimnázium High School Sopron, Hungary. This group belongs to the Hunveyor-Husar Project, leaded by Szaniszló Bérczi. We build and program robot-rovers, that can autonomous move and measure on a planetary surface.

The structure of the HUSAR-5 rovers: These robots have a radio-controlled rover base. We build arms and other complementary elements – depending on the actually mission - from Technics LEGO. Sometimes these arms rotate a lens, or let down an indicator ribbon or a coil. The rover is controlled by an intelligent, programmable brick: the NXT (from the LEGO Mindstorms Set). We use some sensors from this set too, for example ultrasonic sensor. We have to transform the other sensors (gas-sensor, photoresistor) to LEGO-compatible. HUSAR-5 usually has got a wireless camera on the board.

Missions of the HUSAR-5 rovers: The group worked in 3 greater mission. The idea of the first experiment was found out by our group, the others were adviced by the project leader. Because of an unfortunate environmental pollution (Red-mud sludge) we could try our rover on a Red River (instead of Red Planet) too.

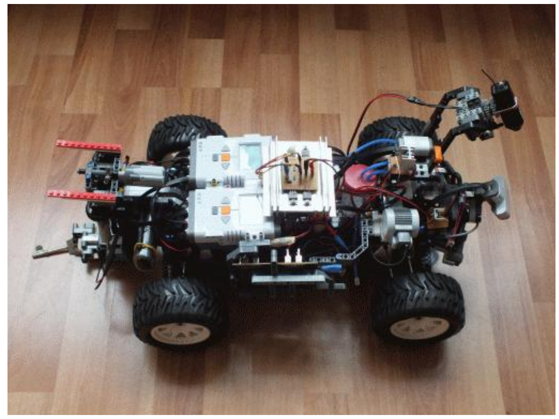
1.Chemistry experiment measuring (pH) of the "planetary" soil. The rover had the first experiment to build: measuring the chemical characteristics of the soil on the surface of a planet by using the indicator method.

The principle of the classical experiment is that a liquid can wet the indicator ribbon and the changing color indicates the pH value of the liquid. If water is poured to the soil surface it dissolves important chemical components from the soil and the indicator ribbon reports the main chemical characteristics of this chemistry. For a field-rovering car model we constructed two arms and a pump. On the first arm the wireless camera was placed, which could rotate around 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. Pouring water, the indicator arm touch the soil. Indicator ribbon arm rolls the ribbon. The rover moves backward to prepare observation of the rolled indicator surface, which holds the information about the pH of the soil. The result of the experiment on the indicator ribbon is transfered by the camera. [1]

In October, 2010, heavy industrial catastrophe polluted the Marcal river in West-Hungary. Our idea was to carry out – a planetary analog type – field works with the rover on the polluted region. The locality was about 100 kilometrs from our town. We visited 3 times the region. So we could try how our experiment works in a real field. We learned very much how much to think in a real mission, and how important is a test on a planetary analog field. We also learned much from our failures, too; for example that contrary to the planned and programmed works it is important to send new programs to the rover. [2]

2.Optical-chemistry experiment measuring gases. The rover uses optical lens as classical heating experiment and uses gas-sensors in measuring the chemical components liberated by the heating.

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 focusing process is the next: 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 beta 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 alpha angle. 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. This H calculates the program using the alpha and beta angles.[4]
3.Carbonate rock colleting. The discovery of the first carbonate meteorite (Bérczi et al. 2012) [3] which have fallen at Nagykovácsi, focused our attention to this type of rocks for identification by robotics methods on planetary surfaces. This experiment for the Husar-5 rover consists of steps of the technology of procedure of finding carbonate specimens among the rocks on the field. 3 main steps were robotized: I. identification of carbonate by acid test, II. measuring the gases liberated by acid, and III. magnetic test. It is known that dropping acids produce rather quick reactions with carbonate rocks. This is the first robotic work to realize by electronics. The CO_2 gas produced will be observed by gas sensors. This is the second act to be robotized. Of the carbonates some are paramegnetic, especially siderite (iron-carbonate). This results in a third step: magnet contact and attraction of siderite by magnet.
The sequence of the measurement is the following.



1) the camera – after giving panorama images – turns toward the soil surface, 2) the dropping onto the rock surface 3) at the same time the gas-sensor starts to move down above the rock 4) evaluation of the gas-sensor data 5) if CO2 is present the magnet-test begins, therefore the rovers moves forward into a good position for the coil lowering 6) the Hall-sensor also moves down and measures 7) magnetization 8) after magnetisation the Hall-sensor makes a new measuring 9) final calculation of the paramagnetic measurement 10) summary of the 3 tests.[5]

Summary: This experiment buildings were a great tasks for high school students, but they enjoyed the work and learned very much.

References:

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