DEVELOPMENT OF THE HUNGAROSPHERE: THE HUSAR-11 ROVER WITHIN A TRANSPARENT SPHERICAL SPACE PROBE MODEL WITH SPECIAL PLANETARY SURFACE ACTIVITIES. A. Gilyén[1] and P. Szvoboda[2], [1]Eötvös University, Faculty of Science, H-1117, Budapest, Pázmány Péter s. 1/c. Hungary, (gilyenandras@gmail.com), [2]Budapest Polytechnik (Bánki Donát Faculty of Mechanical Engineering) H-1081, Budapest , Népszínház utca 8. Hungary, (szvobomeister@gmail.com).

Introduction: In planetary surface activity there are benefits of a rover without outer offshoot or appendices. The tumbleweed uses such benefits, but it is pushed forward by the winds. We developed such a smooth spherical rover, which moves by inner driving. We collected the benefits of such a probe we called Hungaroszféra (Hungarosphere). We built the instrument and used it even on the surface of water.

Hungarosphere: In the St. Margaret High School, Budapest, we have heard a lecture about the Hunveyor construction [1], however, it was too simple for us, therefore we began to build a specific rover.

The main aim of the project is to build a robot capable to move in various environment and to be controlled wirelessly. The robot will be able to explore the environment.

Fig. 1. The Hungarosphere rover is a transparent sphere with inner driving by 4 motors. It can follow any directions in any time.

Requirements:
- Should not get stuck because of a sixth wheel as other robots.
- Should be fully closed (to be resistant against water and sand)
- Should be big to be able to surmount the terrain obstacles.
- Should be light according to its size.
- Should not fall over easily.
- Should be relatively fast.

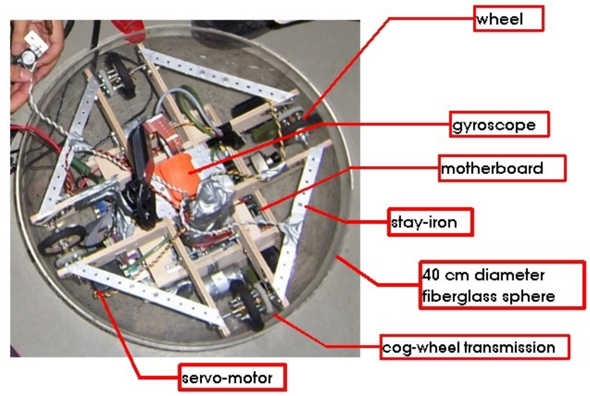

Fig. 2. The construction

Structure: Hungarosphere is a 40 centimeter diameter plexy sphere. [Fig.1.] The transparent sphere allows to see the main motion structure. The sphere could be opened and closed at the "equator". All the accessories are placed in a cross-like skeleton. [Fig. 2.] The batteries and the mainboard are the heaviest on the bottom of the frame. It is really important, because the closer it is to the surface of the sphere, the higher gradient the robot can climb. The robot can roll with the moving of the weight on the bottom. The four motors and wheels are on the edge of this frame. The skeleton is placed below the "equator" of the sphere. This emplacement was important in stabilizing the main position, because this way the centre of gravity is below the symmetry centre of the sphere. The robot can move in every direction by changing the speed of the wheels. The stabilization was governed by a gyroscope. The sphere is fully closed so the Hungarosphere can swim with some plastic oars. [Fig.3.]

Fig. 3. The Hungarosphere can swim

Navigation and control: Because of the gyroscope the rover recognizes the main points of the compass. The gyroscope is connected to the computer mainboard. The four motors are programmed to follow any direction in the sphere (simply on the basis of the vector summation rule). The robot has a self test system: if something disturbs the robot (e.g. the sphere starts rotating because of the surface), the robot keeps the specified direction. When the robot stops and the sphere starts to pitch it stops this movement, too. It is a benefit that the spherical shape does not allow the turnover. It can climb up the slope, depending on the friction. In the sphere there is a camera which continuously can send images of the environment. Commands can be given to the robot by radio signals. The moving direction can be changed 10 degrees with a wireless keyboard.

The internal operation [Fig. 4.]:

- The Control unit is a Mini-ITX PC mainboard.
- For storing the control program (written in C++ language) and the Operating System (which is a free Linux distribution called DSL), a Compact Flash memory card is used instead of a winchester, which would not allow fast moving and would come with too much weight.
- The computer controls the motors via the LPT port.
- The gyroscope is connected through Rs-232 interface. It gives orientation, gyration and acceleration data in 3D so the program can do a lot of self tests about the movement.
- The robot has a CCD camera but it is a fully separated system. The controller person can watch the environment through this.

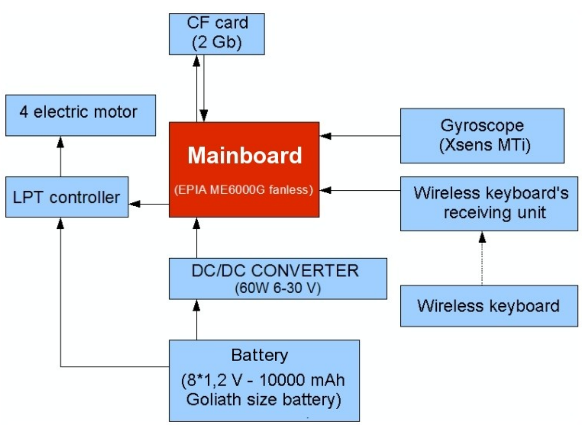

Fig. 4. The internal operation

Benefits and possibilities of Hungarosphere: This sphere robot has a lot of advantage which makes it a really great explorer robot. This robot can not fall over or sink in the water. It's fully amphibious. Especially the low weight and easy-moving makes it ideal for space research.

There are several benefits of such a rover construction. All the instrumentation is inside the sphere and no dust interaction and pollution from the planetary surface distract the activity of the probe.

The rover can follow a surface object even if it is just bottom of the sphere. This capability is a special benefit if the rover is riding a fluid surface. This capacity may be useful for Titan lander and rover program.

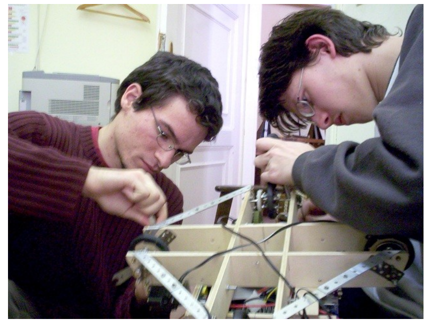

Fig. 5. Construction of the mechatronics of the Hungarosphere motors.

Further development: We tested the rover on various conditions, but it's not perfect, it's only a prototype, so we will develop it.

We solved the moving of the sphere by special mechanics and the remote control of the robot. The robot keeps the specified direction automatically.

In the future we will solve the remote control from a further distance. We will repair the mechanics of the sphere in order to be able to climb steeper slopes, too. We will develop the software of the robot to be able to avoid obstacles. We will equip the robot with measuring devices: thermometer, radiometer, solar cells, pressure gauge, sensors to the definition of the distance

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References:

[1] Sz. Bérczi, V. Cech, S. Hegyi, T. Borbola, T. Diósy, Z. Köllő, Sz. Tóth (1998): Planetary geology education via construction of a planetary lander probe. In *LPSC XXIX*, Abstract #1267, LPI, Houston (CD-ROM).;