Life on Mars (*Mindstorms: Water Detection on Mars*)

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Introduction

Although the interest in finding life on other planets is not something new, it is true that at present a great amount of research and missions are being developed that aim to deepen more in the knowledge of the necessary requirements for life to arise. At the same time, technology continues to advance, and what until a few years ago was an exclusive subject of science fiction, is now a subject of the covers of newspapers, magazines and television programs: the sending of manned missions to other planets in order to create human colonies. Some eminent scientists posit it as a necessity of survival for humanity, as for example Stephen Hawkins.

In this project we look for two fundamental objectives: to deepen the knowledge of this subject and to contribute our granite of sand to its diffusion.

Abstract

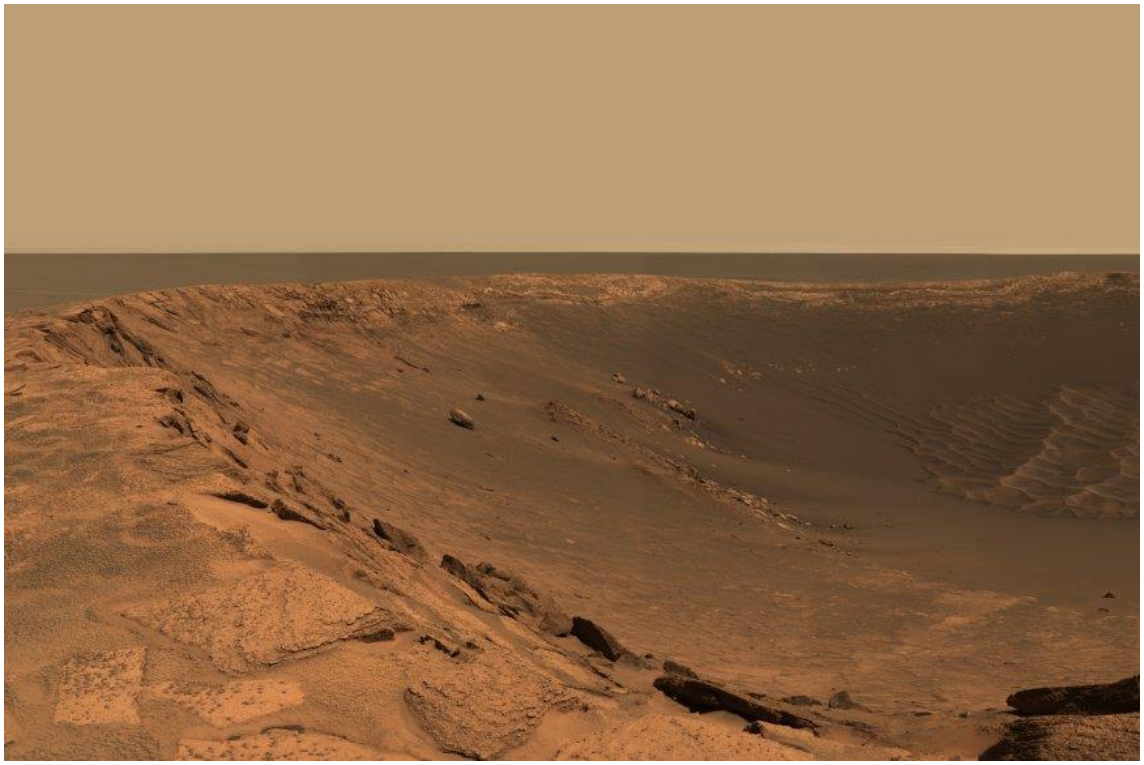
"Habitability" is defined as the quality of the planets or any other celestial body to host life.

One of the great concerns of scientists is to discover if there is, or existed, life on other planets. The planets of the Solar System: Europe, Titan, Enceladus and Mars are those that have the habitability conditions necessary to be able to shelter life. Mars is the best candidate. Although we know that the atmospheric conditions of Mars in the past were much more optimal for the development of life, due to the presence of liquid water and because the temperatures were milder than there are today, terrestrial extremophiles

demonstrate that life can adapt to many conditions, so it is not ruled out the possibility that it develops on Mars.

In order to know if this is possible, it is necessary to study the necessary conditions for the development of life, to investigate terrestrial environments similar to Mars and their respective inhabitants (extremophiles) and to send missions of exploration of Mars. In our project we emphasize the importance of these missions in the knowledge of the composition and geology of other planets. To do this, we simulated these vehicles sensors for detecting an element. Specifically, water on Mars.

It's an exciting topic, and we wanted to adapt to the possibilities of our LEGO MINDSTORMS EV3 by simplifying detect water.



Endurance crater photograph by Rover Opportunity. Credit: NASA / JPL / Cornell

Necessary conditions for life on Mars

All forms of life (on Earth) need water to live in any of the three states but preferably in a liquid state. That is why the first thing that is being sought on Mars to know if there is life or possibility of existence is water. At the moment the ice is known

in the Martian poles, although there are also high probabilities that there are water under the surface certain territories on Mars. Water forms almost 60% of our body as it is essential for our tissues to develop and fulfill their functions. Water is the origin of life and is essential for the physical-chemical processes of all organisms.

The different forms of life need nutrients to feed and metabolism, so the presence of these is required so that life can exist.

Not only is the existence of water and nutrients necessary for life, but also energy. That is why projects are underway to find sources of energy on Mars.

There are other factors such as temperature, distance to the sun, protection against ultraviolet rays, soil fertility, humidity, pressure, gravity ... which affect in one way or another the existence of life.

Habitable zone

To know if there is life in another planet is necessary to answer a previous question, its habitability.

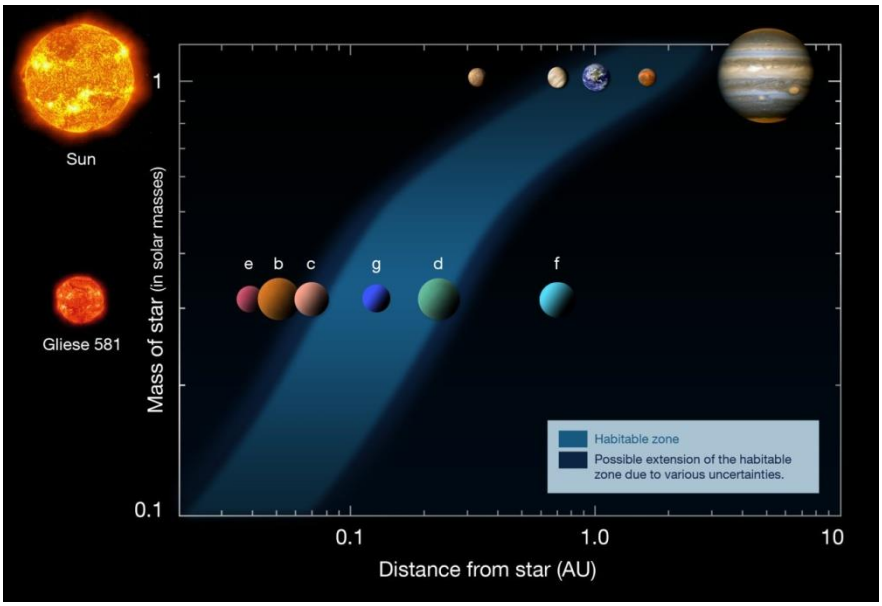
Definition of habitable zone:

"*Zone of the space around a star in which the planets or satellites that are in her are susceptible to harbor life*." SEA http://www.sea-astronomia.es/drupal/node/352 .

Not all stars can have a habitable zone. The conditions for this to occur are that it has to live for several billions of years to allow life to appear and evolve, that the ultraviolet radiation it emits is sufficient for the formation of an ozone layer, and Of course, to allow the existence of liquid water.

In addition, these stars do not have to be variable in luminosity and must have high metallicity (relative abundance of elements heavier than helium in a star), this is because the concept of "habitable zone" has been extrapolated from Earth - Which is the only known planet that harbors life - and therefore it is believed that the habitable planets must be of rock type, just like the Blue Planet.

With respect to the planet, it needs to be large enough to have a considerable atmosphere. It is also necessary that the day-night cycle (which depends on the orbital speed) is not very long, so that there is not much temperature difference between day and night.



Graph showing the habitable zone of the solar system. ESO / L. Calçada.

Features Mars

After this introduction, we focus on Mars.

It is a planet with characteristics very similar to the Earth.

Mars has two moons that are: Phobos and Deimos. The diameter is approximately half that of the earth having a smaller gravity.

The length of a day on Mars is 24.6, so that a year would be 687 days equivalent to the days and hours on the land surface.

Its reddish color is due to the fact that the iron found on its surface oxidizes and gives it that characteristic color.

It has a very thin atmosphere in proportion to that of the Earth, and does not possess the ozone layer capable of protecting the surface of Mars from the arrival of ultraviolet radiation.

This atmosphere is composed mostly of carbon dioxide (CO2) by 95%, and nitrogen (N2) by 3%. Unlike in the terrestrial surface, where there is 78% of nitrogen and 21% of oxygen.

The temperature of this planet oscillates between -60ºC and -5ºC. The characteristics of this planet are very different from those of its past. This is largely due to the wind forming dust swirls, creating mini tornadoes. Most of Mars is very old and full of craters, but at the same time we find crests and hills.

There are certain differences between the northern and southern hemispheres that are thought to be due to an impact shortly after their formation.

Similar terrestrial environments on Mars and extremophiles

For an analogous terrestrial environment, we mean a place of similar conditions to the terrestrial planet.

On our planet there are many environments analogous to Mars and are the ideal places to investigate and determine the possibility of life on Mars:

For example, the Atacama Desert in Chile helps us better understand the extreme aridity of Mars.

Ignimbrite rocks in the Atacama desert. Credit: Jacek Wierzchos.

Timanfaya National Park Lanzarote. Credit: NASA / JPL-Caltech.

Timanfaya Park is a large area affected by volcanic activity, as is the Martian planet.

The Antarctic cold recreates the extreme temperatures of Mars.

The Antarctic cold recreates the extreme temperatures of Mars. Credit: NASA / JPL-Caltech

Dry valleys of Antarctica (better known as the Antarctic Blood Falls). Credit: NASA / JPL-Caltech.

The acidity of the Río Tinto is characterized by that of Mars due to the presence of sulfates, oxides and other minerals. Credit: CAB

These geological environments have very extreme conditions and the organisms that inhabit them are called extremophiles.

Extremophiles are microorganisms capable of adapting to very extreme life conditions, from the colder to the warmer environments.

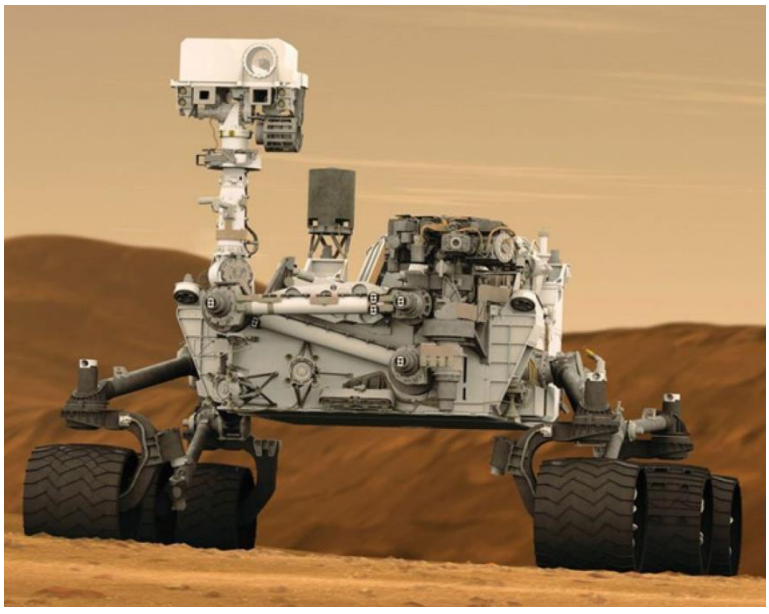
There are extremophiles who do not need water to live (xerophilic), others who withstand high pressures (piezofilos), those that can withstand very cold (psychrophilic) or very warm (thermophilic) temperatures, those with high radiations Are adapted to very salty (halophilic), alkaline (alkalophilic) or acid (acidophilic) places that are found in the Rio Tinto.

The existence of all these extremophiles increases the possibility of life on Mars and also that from Earth we can investigate and experiment with all these environments with conditions and characteristics similar to the Martian.

Following recent experiments with Antarctic fungi (Cryomyces antarcticus and Cryomyces minteri), the International Space Station has determined that more than 60% of them have survived for more than a year and a half to Martian conditions. The main objective was to send to the ISS to see if they could overcome the cold and endure the Martian atmosphere. The result was optimal, as more than 60% of these fungi remained intact, ie the stability of their cellular DNA was high.

Curiosity

Curiosity is the name of the MSL - *Mars Science Laboratory*. It consists of a space mission that includes a true "*walking laboratory*" directed by NASA. It was released on November 26, 2011.



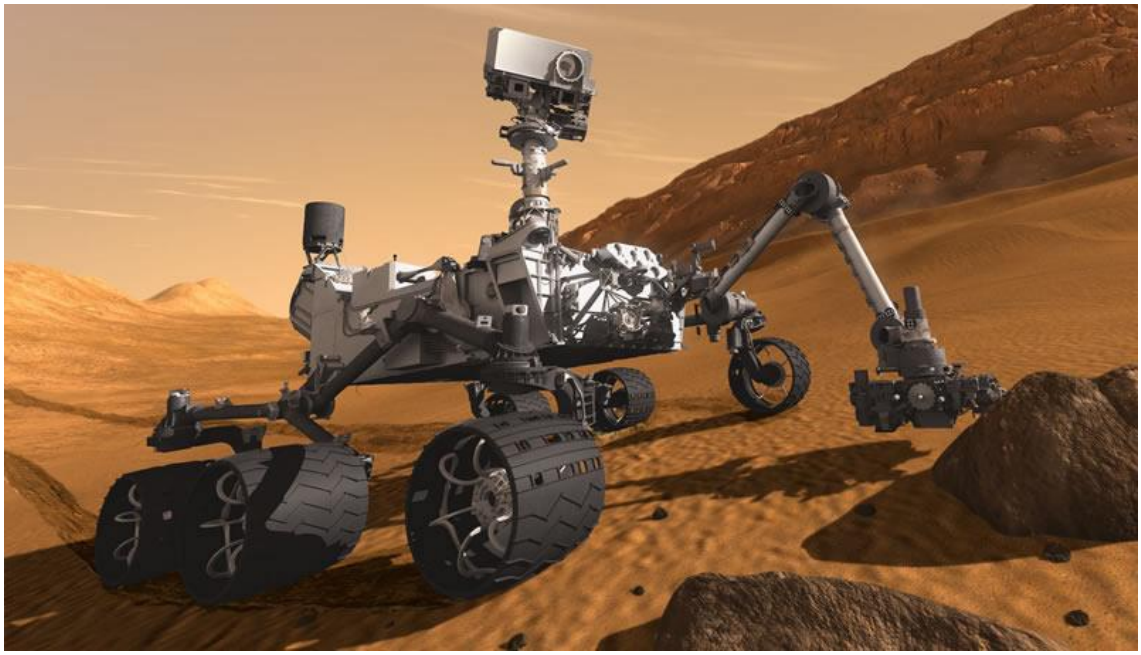
Rover Curiosity. Credit: NASA/JPL/Cornell.

The main objectives are to determine whether life ever existed on Mars, to characterize the Mars climate, to determine its geology and to prepare for the human exploration of Mars.

For this, it has a series of instruments: cameras, spectrometers, radiation detectors, environmental sensors and instrumentation for entry, descent and landing. So far, Curiosity has already sent us a lot of information, but without a doubt, the most important finding has been the confirmation that on Mars there were the conditions necessary for the existence of living microorganisms a long time ago. This has been discovered by crossing ancient channels and exploring a place where formerly a lake was located: there Curiosity took samples of the bottom of the lake, which led to reveal the evidence of fresh water. He also found organic molecules containing carbon in a usable form for life. This leads us to think that if there was ever life on Mars, this ancient lake might have been the ideal place for its development.

Curiosity traveled long valleys taking photographs of the geology of the planet and traveled to Mount Sharp, where he could find signs of ancient water. Currently, the rover is on a 6-meter hill, as one of its spectrometers went up, it showed that the amount of silica in nearby rocks was getting higher, which leads us to ask new questions that we hope can be solved in the future.

[Video: Curiosity rover report, three years on Mars: https://www.youtube.com/watch?v=Txti0XLxOzI]



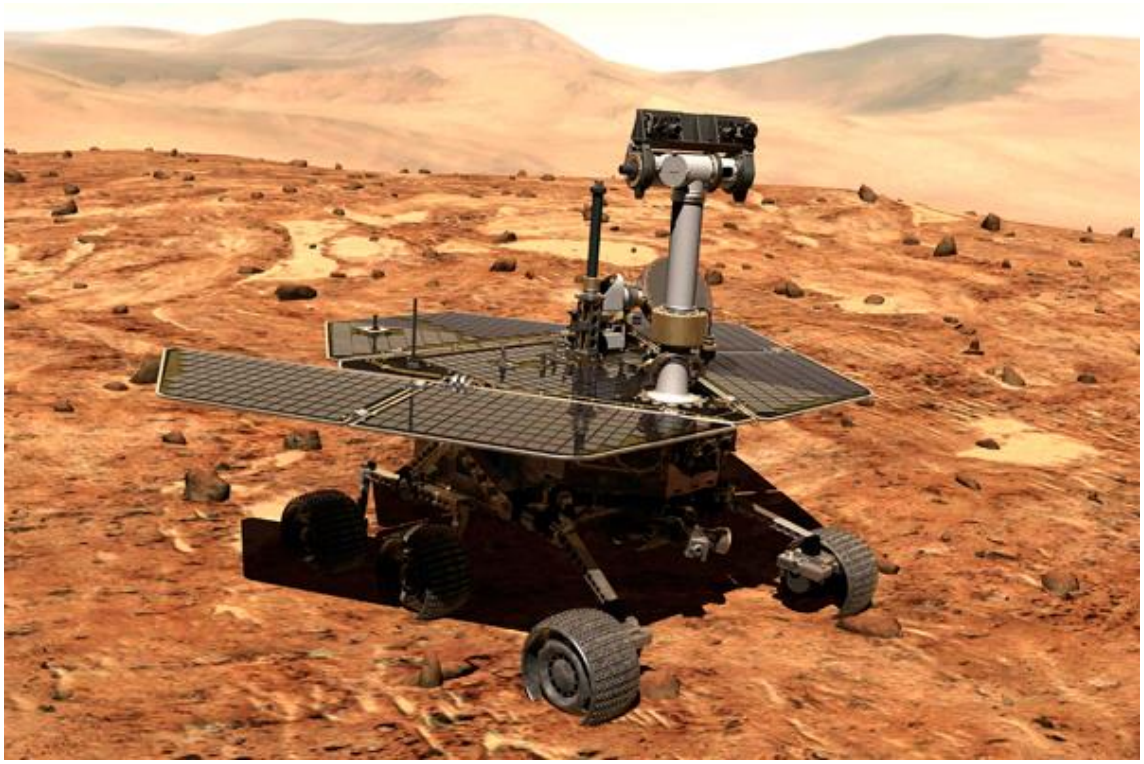
Artistic concept of the Curiosity rover on the Red Planet. Image Credit: NASA / JPL-Caltech.

Opportunity Mars Rover

The Opportunity Rover is a vehicle sent to Mars in order to further investigate the Martian planet, water stocks, craters, sending panoramas to Earth.

The rover operators plan to send another one of these vehicles the next Martian winter to determine the amount of clay materials that the soil of Mars contains. NASA's Mars Exploration Project landed twin rovers (Spirit and Opportunity) on Mars in 2004 to begin planned missions over three months. Both rovers passed that time. Spirit worked for six years, and Opportunity remains active. Findings on ancient humid environments on Mars have been detected by both rovers.

There is a NASA project proposed before 2030 that humans are going to reach Mars and the rovers are going to become very important. Beginning in 2018 will begin to organize and prepare the project so that by 2030 the human being has stepped on the Martian lands.



Opportunity Mars rover. Credit: NASA/JPL-Caltech

Signs of the possibility of life

It is now known with certainty the existence of ice in the Martian poles. In addition, there is evidence that there is liquid water on Mars; Some cracks in the surface of Mars that apparently could be channels of the water have been discovered, although it is not known with certainty.

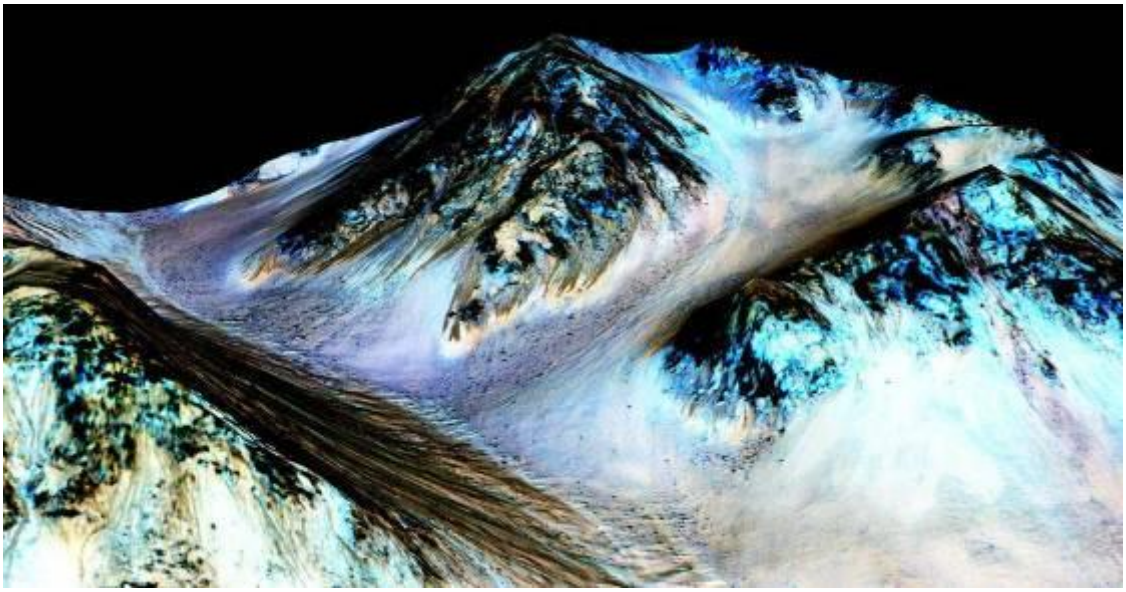
Traces of methane have been detected in Mars' atmosphere. According to the data obtained by the Curiosity the amount of methane has decreased considerably, so it is ruled out that it is of biological or geological origin. The origin of methane may be due to the impact of meteorites.

Temporal stains have also been detected in the dunes that are the product of cold geyser eruptions.

Because of the radiation from Mars, the best place to find life is the depths of Mars.

The project

In our project we want to emphasize the importance of these missions in the knowledge of the composition and geology of other planets. To do this, we simulate the sensors of these vehicles to detect an element. In particular, water on Mars (already have 2015 photos from NASA demonstrating the existence of liquid water on Mars, see the following image).



The dark spots of the photograph might be water flows. Credit: NASA / JPL-Caltech / Univ. Of Arizona.

It is an exciting subject, and we wanted to adapt them to the possibilities of our LEGO MINDSTORMS EV3 by making it simpler to detect that a bluish tone was supposed to have discovered water (on Mars). The robot then had to do a series of actions. The immediate would be to communicate to the tracking team of Planet Earth: in our case the LEGO MINDSTORMS EV3 emits a humanoid voice that we have previously recorded in mp3 format, communicating the existence of water.

Secondly, the robot performs a "ritual of celebration", for this we have programmed a series of turns on itself, as a "dance".

Performance

The steps for the realization of the project were:

1.- Storm of ideas: to evaluate in group the possible options and the realizable options.
2.- Choice of what one wanted to do: all ideas were reduced to two:

2.a.- Robot following white light.

2.b.- Robot that detects change of color in extraterrestrial surface to detect the presence of water. In the end the latter was chosen.

3.- Programming: documentation with tutorials. The program was installed in a TABLET SAMSUMG TAB 3 and the beginning of the project was done in it. Finally, the executable was also installed on a laptop with WINDOWS 7 finishing the work on it.
4.- Each program was turned over to the Robot via USB / Bluetooth to test its correct operation.
5.- Finally it was decided to change the standard voice emission of the robot by a recorded mp3 simulating humanoid voice.

Difficulties

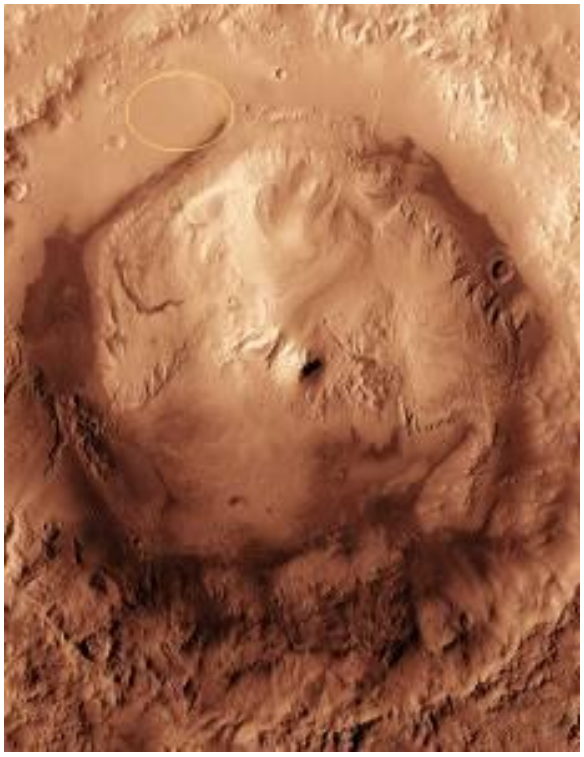
We must say that the greatest difficulty was to understand what the teacher asked us to do. It costs to start an investigation, initially does not know where to start. Little by little we have been collecting information, ordering it conveniently in different folders to achieve the ultimate goal.

Once that phase was over, and considering that we had never done anything robot programming, we had to learn, from small explanations of high school students who have served as a base to go deeper, searching information on the network. Once we have made the program work and the robot detects a change of color towards the bluish, we wanted to go further, programming the same so that it emits a humanoid voice on the discovery of water. For this we have linked a mp3 file of voice within the source code of the program of detection blue color.

Disclosure material

Screenshot of our poster.

In addition to the poster, we have printed a large-sized image of the Gale crater, in honor of the Curiosity landing:



Scenario on which our robot searches for water.

Mars team at the II Feria de la Ciencia y Tecnología de Castilla y León (Burgos, España).

Disclosing our project in the Ciencia en Acción (Science in Action) fair, Algeciras, Spain.

We got an Honorable Mention.

More information about our Mars Global Project: https://2016space.wordpress.com/

We have published a small episode in the book “2016 Space. Conquistando el espacio” (*2016 Space Conquering Space*) [p. 53]. A digital version can be obtained at: https://2016space.wordpress.com/2016/09/06/2016-space-el-libro/

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