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AGENCIA BOLIVARIANA PARA ACTIVIDADES ESPACIALES

United Nations/China 2nd Global Partnership Workshop on Space Exploration and Innovation

PROPOSAL FOR A VENEZUELAN NATIONAL PROGRAM FOR ROBOTIC SPACE EXPLORATION

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Summary

The future of space exploration is increasingly supported by robotic platforms as a tool for the study and understanding of the universe, as well as in preparing the conditions for future missions and human settlements. However, the development of these robotic missions is, in essence, a risky and difficult activity which often coexists with the uncertainty and adverse conditions of remote operations, where there is no option for help or rescue.

To increase the chances of survival and mission success, swarm robotics systems have been proposed as a new paradigm for space exploration, providing robust and reliable platforms that allow the exploration of the Solar System in a totally new magnitude and scope.

This proposal called “Venezuelan Program for Robotic Space Exploration”, focused on swarm robotics , aims to offer the country the possibility to develop and position itself, permanently and its own feet, in the space sector.

Disadvantages

Low autonomy

Space exploration platforms rely heavily on centralized control for the execution of planned exploration and scientific study tasks. This drastically limits its operating potential, since only previously scheduled and approved activities are carried out, and there is no room for autonomous decision-making.

Low performance

The centralized control and lack of autonomy of current robotic platforms for on-the-spot decision-making, coupled with changing conditions in outer space, limit the performance of current robotic platforms. They are incapable of proposing and executing action alternatives, based on their privileged position on the ground.

High vulnerability

Current robotic platforms are complex and sophisticated. They have a large number of mechanisms, equipment and instruments that inherently have the possibility of failure. But a failure in a single robotic platform has great consequences, because it can imply the partial or total failure of the mission.

Swarm Robotics

***Definition*:** Swarm robotics is a research field in artificial intelligence, responsible for the development of new organization and coordination mechanisms, decentralized and distributed, of robotic entities with relatively simple structures, which develop intelligent collective behavior through their interaction with others entities and their environment to solve complex tasks. Some of the main features of robotic swarms are their self-organization, scalability and resilience. It is a **fault-tolerant system**.

Ants "Eciton hamatum"

Space Exploration
with Swarm Robotics

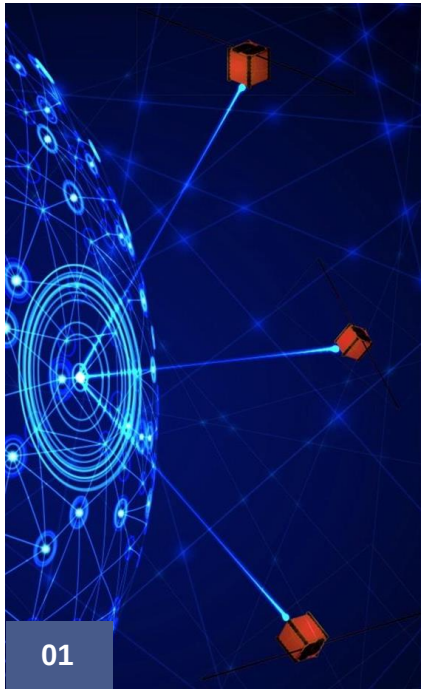
Definition: Swarm robotics space exploration is the use of swarm of robots to plan, coordinate, and perform space exploration missions. From the surfaces of planets, through moons, asteroids and other celestial bodies.

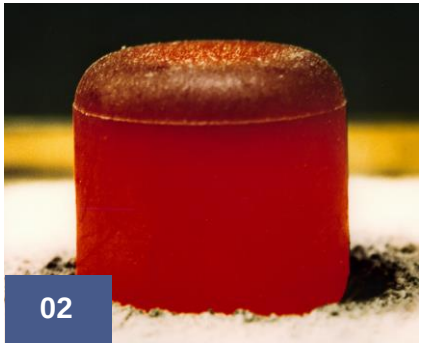
The swarm ensures resilient and persistent space exploration on a whole new scale, magnitude, and scope. However, it imposes new challenges for managing high levels of complexity in the field of communications and networks, control and navigation systems, as well as data management.

Kilobots, Harvard University

Challenges

01 | Communications
02 | Energy
03 | Space Environment
04 | Propulsion
05 | Control & Navigation





Program Purpose & Goals

Develop national capacities in autonomous robotic platforms, to carry out space exploration missions in all its modalities and permanently in the Solar System. The program is designed to be completed in 12 years, from 2024 to 2036.

1. Develop an intensive and top-level education and research system to support the national space industry.
2. Develop an autonomous, robust and reliable robotic swarm platform to guarantee the permanent exploration and study of the Solar System.
3. Develop a high-tech national space industry to produce high value-added products and services.
4. Guarantee Venezuela involvement, permanently and its own feet, in the international space arena.
5. Develop Space Dynamics Navigation Routes (SDNR) for the Solar System exploration.

Education

For all levels and areas of education (formal, non-formal and informal). A curriculum with emphasis on Science, Technology, Engineering, Mathematics, Design and Science Fiction is proposed. The purpose is to develop problem-solving skills, creativity, innovative thinking, multidisciplinary teams and proactive attitude.

01 | Teachers education

02 | Space-related educational opportunities

03 | Promote studies on the subject

04 | Specialized education

Educate teachers to train other teachers.

01

Training at all levels of education system, with a wide offer of content and courses (primary & secondary education).

02

Careers and studies related to space robotics. Also competitions and events to promote the space theme.

03

Develop specialized educational plans and facilities for young researchers and entrepreneurs.

04

R+D+i

High-level research, development and innovation, relevant and related to the robotics space exploration objectives.

01 | Financing

02 | Protection of intellectual property

03 | Advanced research instrumentation and facilities

04 | International cooperation and exchange

High-level space projects and lines of research developed by universities and research centers.

01

Intellectual property and patents generated by the program.

02

Create research facilities to develop cutting-edge technologies in the field of advanced space robotics.

03

Nationally and internationally cooperation between researchers, entrepreneurs and government.

04

Entrepreneurship

It aims to boost national productive capacities in the space sector, through access to capital and training, to consolidate initiatives that are innovative and develop high value-added products and services.

01 | Training for entrepreneurs

02 | Business models formulation

03 | Entrepreneurship formalization

04 | High value-added propositions financing.

Training in entrepreneurial management and administration. **01**	Definition of the productive proposition within a sustainable business model. **02**
Registration and formalization of enterprises, as well as advice on compliance with industry standards and regulations. **03**	Credits to entrepreneurship, support and advice in business strategies, marketing and networking. **04**

Government

Public policies and government strategies must be generated to promote and consolidate the generation of knowledge, cutting-edge technologies, products and services with value differentiators in the field of advanced space robotics.

01 | Formulate, develop and implement public policies

02 | Funding, support and monitoring

03 | International cooperation and exchange

04 | Synergy between R+D+i and national entrepreneurship

To promote high-tech intensive R+D+I and productive activities with high added-value. **01**	Lines of research and projects related to the programme. **02**
With partner countries that have extensive space expertise. **03**	With the aim of positioning proposals of high added-value in international markets. **04**

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E Explorer	Exploration, reconnaissance and scientific studies of the environment. Presents three (3) types: surface, aerial and underwater.
O Orbiter	Intelligent remote sensing satellites for celestial body studies, as well as communication link between mission control and the explorers. It's configured to work in constellation arrangement, decentralized, distributed. Designed to be multi-purpose and multi-orbit.
C Collector	Collecting samples from sites of scientific interest of the celestial body under study. These samples are later sent to Earth or another destination. The collector is deployed and recovered by the mothership, called "the transport".
T Transport	Transport all platforms to their destination. These platforms can increase their number as required by the mission. It performs logistics functions, refueling, managing samples from collectors and to store new platforms in the event of failure or loss.
A Accelerator	It provides acceleration assistant throughout the Solar System to develop low-cost, fuel-efficient space navigation routes. This also allows spaceship to be progressively accelerated over long distances or slowed down for orbit insertion.

Program Schedule

2024-2026

Phase 1

Earth Surface-Orbit

E(sau) O

2026-2028

Phase 2

Moon Surface-Orbit

E(s) O C

2028-2030

Phase 3

Venus & Mars Surface-Orbit

E(sa) O C T

2030-2034

Phase 4

Asteroid Belt

E(s) O C T_n

2032-2036

Phase 5

Jupiter & Saturn Surface-Orbit

E(sau) O C T_n A

E Explorer
O Orbiter
C Collector
T Transport
A Accelerator
s surface
a aerial
u underwater


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