Spatial exploration in Paraguay: State of the Art. A brief history for the project of the first satellite mission of the Republic of Paraguay

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Abstract: From the time of the pre-Columbian indigenous culture, and like all the original American beliefs that populated the Paraguayan territory from the past, the Guarani projected their environment in the sky and tried to explain the stars and celestial phenomena. But it was not until the arrival of the Jesuits in the year 1600 that they began to explore in a scientific way the Guaraní sky, since there are records of astronomical observations and meteorological realized in the missions, from the own construction of telescopes, Which allowed the observation and prediction of eclipses of sun and moon. However, since only in 2014 was formed the Paraguay Space Agency, where this institution, which covers various political and civil estates, will be in charge of the preparation of the National Satellite Program, which will also regulations on aerospace issues. From this station, and taking advantage of the support provided by the National Council of Science and Technology of Paraguay (CONACYT), the Itaipu Technological Park - Paraguay is link to INVAP SE - Argentina, in order to develop the feasibility study for the first mission Satellites in Paraguay. In this sense, this paper aims to present the state of the art of space exploration by the Republic of Paraguay.

1. INTRODUCTION

From the time of the pre-Columbian indigenous culture, and like all the original American cultures that populated the Paraguayan territory from the past, the Guarani projected their environment in the sky and tried to explain the stars and celestial phenomena. They conceived the earth as an island or continent floating in an infinite plane ocean. Sky was the space where these inhabitants forged their world, which eventually became part of our history and identity.

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The spirituality of the Jesuit missionaries, who in the XVII century founded the reduction of San Cosme and Damian in southern Paraguay with the purpose of evangelizing the Guaraní Indians of the region. Among them stands, Buenaventura Suárez (1679-1750), considered the first astronomer of Paraguay. Suarez dedicated himself to the observation of the stars influenced by the Guarani knowledge, who knew the cycles of the stars propitious to sow or to harvest. Thus, he bequeathed documents as a prediction of lunar phases and eclipses for a century [1].

However, from this, very little progress has made in the field of space exploration in general, and satellite mission in particular in Paraguay.

Since only in 2014 was formed the Paraguay Space Agency, based on a decree emanating from the executive branch, where this institution, which covers various political and civil estates, will be in charge of the preparation of the National Satellite Program, which will also regulations on aerospace issues [2].

From this station, and taking advantage of the support provided by the National Council of Science and Technology of Paraguay (CONACYT), the Itaipu Technological Park - Paraguay is link to INVAP SE - Argentina, in order to develop the feasibility study for the first mission Satellites in Paraguay [3].

In this sense, this paper aims to present the state of the art of space exploration by the Republic of Paraguay. This particular project fits within the challenge of the technological challenges associated with space exploration, and of its derivatives, the progress in research and development. The task of advancing projects in the aerospace field gives the country new limits of technological-scientific progress, which can be apply to other areas.

For Paraguay in particular, the development, application and use of space technologies play a prominent role, to the extent that it allows the generation of an organized industry, territorial planning and development. In addition to promoting new technical, scientific and technological horizons, and leading the country to position itself internationally in this field.

This project seeks to obtain a feasibility study, with a view to generating future projects of satellite development for the country, even taking into account that our country is the only one, which currently does not have its own satellite in South America.

Subsequent sections present a report on the creation of the Paraguayan Space Agency, the advances in the space area in the academy, a brief summary of the project "Feasibility study for the first satellite mission of Paraguay", to finally present the Conclusions of this work.

2. CREATION OF THE PARAGUAYAN SPACE AGENCY [2].

In 2014, the Paraguayan Space Agency (AEP) was conceived, based on a decree issued by the executive branch, where this institution, which covers various political and civil estates.

The creation and operation of a specialized body for the use of space is a gateway for Paraguay to strengthen knowledge about the earth and outer space, using modern technologies that allow, on the one hand, connectivity and communication with the national territory employing directly and indirectly the telecommunications space technologies [2].

In this sense, the importance of the advance in aerospace technologies has become in recent years a fundamental part of the development of nations. Beyond the technological challenges represented by space exploration, and derived from them, the advance in research and development, these advances give new limits of technological progress that can apply to another area.

Likewise, the institution will be responsible for preparing and proposing the "National Satellite Program", issuing regulations on aerospace, to propose scientific, technological and academic exchange as well as the teaching, research and dissemination of matters related to space activity, and which will issue regulations on aerospace, among other.

3. ADVANCES IN THE SPATIAL AREA IN THE ACADEMY [4]

In the attempt to join the global community on space exploration, by using low-cost scientific payloads on a balloon-borne platform and, as a result of the creation of the Paraguayan Space Agency in 2014 [2], the program EMOÑEPYRUPY (genesis in Guaraní) was created under the initiative of a local academic institution, i.e., Facultad Politécnica at Universidad Nacional de Asunción. The main objective of this program was to promote space related activities, to undergraduate engineering students and, to audience in general. This first activity was conducted under the mission AEP-UNA-GS001. The academic unit leading this mission was the Department of Aeronautics. The payload consisted on two different global positioning systems, two image capturing devices, a temperature sensor and a pressure transducer for altitude measurement purposes. Similar devices were already utilized for this type of applications such as the one shown in Sreejith A.G., et.al [4]. The total weight of this payload including a radar reflector and a parachute was 8 Newton. The balloon positive lift was measured to 2 Newton. A 600 grams latex balloon was utilized for this mission. This launch was carried out on the clear morning of January 27, 2017, at 7:38 AM local time, 11:38 UTC, on location Latitude/Longitude -5.3571/-57.2567 (Yvytu), San Bernardino, Paraguay. Total flight time was 5 hours approximately. Apogee reached at Latitude/Longitude -25.0/-57.7 approximately, attaining a maximum altitude of 27046 meters from ground. Impressive images from different altitudes as well as video recordings were captured on this mission. Flight data recordings, i.e., Global Positioning Data, Barometric Pressures and Temperatures, were recovered from memory card installed in the flight data logger.

One important finding of this mission was the validation of a Landing Prediction Software, from the Cambridge University Space Flight. This simulation proved to be very accurate in this particular mission. Its prediction was very accurate and match with the two Global Positioning Sources.

4. FEASIBILITY STUDY FOR THE DEVELOPMENT AND IMPLEMENTATION OF A SATELLITE MISSION IN PARAGUAY [3]

Within the framework of the project awarded by the CONACYT for the development of the project "Feasibility study for the development and implementation of a satellite mission in Paraguay", to be developed under modality of an associative project, where the PTI-PY is the leading institution of this enterprise, having as main ally the company Applied Research State Society - Argentina (INVAP).

The project in particular seeks to focus fully on one of the transversal technologies for the development of productive sectors, which is Information Technology (IT) and falls within the challenge of the technological challenges associated with space exploration,

In addition, of the derivatives thereof, the progress in research and development, understanding that the task of advancing projects in the aerospace field gives the country new limits of technological-scientific progress, which can be apply to other areas.

The development, application and use of space technologies play a prominent role, to the extent that it allows the generation of an organized industry, territorial planning and development. In addition to promoting new technical, scientific and technological horizons, and leading the country to position itself internationally in this field. This project seeks to obtain a feasibility study, with a view to generating future satellite projects for the country, especially considering that our country is the only one, which does not currently have its own satellite in South America.

4.1 Objective of the project

The main objective of this project is to provide an information tool (Feasibility Study) that allows an analysis and evaluation, to support the subsequent decision-making, on the implementation of a satellite mission by the government of The Republic of Paraguay.

It is noteworthy that the space sector in Paraguay differs particularly from the countries of Latin America, mainly because there are currently no projects linked to this line. Space activity had a strong dynamism in several countries of Latin America, where are created new institutions, both in the public and private areas, scientific and communications satellites were developed and put into orbit, and many technology-based companies were born.

This context creates the conditions conducive to progress towards greater integration of countries in the space sector. Its complexity and strategic importance require it, in order to achieve greater autonomy of the sector in the region. The importance of advancement in aerospace technologies has become, in recent years, a fundamental part of the development of nations.

It is also expect that the project will promote the training of researchers, professionals and technicians. Thus, based on the results, the bodies to define and execute the space policy of Paraguay through the elaboration and implementation of the national program of space activities, to carry out research tasks conducive to the formation of groups with disciplines and

Necessary techniques for access to space technology and its applications; To carry out tasks of development in advanced engineering, covering the necessary fields to reach an adequate national space technology; Promote the transfer of space technology for use in agronomy, mapping, mining prospecting, meteorology, geology, environment, medicine, communications, defense, industrial or other areas, to state entities and, licensed to the private sector, providing technical assistance to achieve The quality guidelines it determines, and provide technical assistance to the State in space matters, among others. That is why it is essential to take advantage of this first step provided by the project.

4.2 Proposed methodology

For the development of the methodology, the work group decided to distribute the Project in three work packages. The first work package corresponds to the exchange of proposals, later, in the second work package, the development of the study of Feasibility for the development of a satellite mission, which will contain technical, programmatic and economic aspects, as well as a summary, conclusions and next steps to follow in the project. Finally, the third work package intends to carry out the dissemination of the work through presentations to the interested sectors.

On the other hand, what is intended in this proposal is to take advantage of the connections generated throughout its existence of the PTI-PY, that is why it was sought to generate a link with companies dedicated and above all experienced in this type of Projects is concerned. Applied Research (INVAP) has a team of professionals with a vast experience in the management of complex projects related to the aerospace industry, having been constituted as the main contractor in the execution of these projects. Among its strength is the ability to adapt the proposed solution, giving special importance to the client's needs, getting involved and interacting strongly with the client, during all stages of project development.

This work is planned jointly between the PTI-PY and INVAP, which will make available to the project its team of professionals in the different relevant areas to form a multidisciplinary execution scheme based on the experience of having developed satellite missions of Different type. This study will allow us to know in a finished way, what are the potential for the execution of a space mission in Paraguay, which will focus on operational, technical and economic aspects. Based on this, we will have a collection of relevant data on the development of the project, and with this, we can make a decision to proceed with the study, develop or effectively implement it.

4.3 Transcendence of the project

The importance of this project allows boosting the development of the country's scientific and technological capacity is one of the main motivations that underpin the project, as a look towards a future of increasingly knowledge-based societies.

In that sense, it can be considered a valid initiative for the training of human resources, and to contribute to generating the conditions for these resources, in the future to remain and develop their activity in the country.

In general terms, this type of project, taking into account the different types of missions, will contribute in terms of optimizing productive cycles for economic development, in the

forecasting and analysis of natural disasters and phenomena, in the availability of Tools to expand access to education and the provision of valuable information for safety management.

5. CONCLUSIONS AND RESULTS

This paper presents the main actions carried out to promote space exploration in the Republic of Paraguay. It is highlighted that Paraguay is the only South American country that does not have its own satellite. With regard to space exploration, Paraguay has not made much progress.

From the creation of the Paraguayan Space Agency, the possibility of advancing in the field of space exploration begins.

In the hands of the academy, in conjunction with private initiatives are beginning to develop various projects of a spatial nature.

Finally, it is highlighted that thanks to the support of CONACYT, the project "Feasibility study for the development and implementation of satellite mission in Paraguay" will be developed jointly between the Itaipu - Paraguay Technological Park and INVAP - Argentina.

6. REFERENCES

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