Application form

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| Project title: | Satellite Ground Station Using Signal Defined Radio |

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Summary

Small-size satellites are seriously in research not only for studying but also supporting the commercial purposes. Because of their small dimensions, it is convenient for the unique tasks such as: relaying signal, local area observing, environmental index measuring… which would down the price of both manufacturing and launching process. Therefore, small-size satellites are more and more be interested in. SVOM projects … launching satellites and

Relating to jobs of satellites mentioned above, they need the system called Satellite Ground Station (SGS) for receiving control signals and communicating. Usually, the host (who has satellite launched) will own or renting one or some system for operating. However, orbit time for satellite does not allow it to link to the SGS all the time. The bigger orbit radius, the longer satellite can contact to its SGS. Most of small-size satellites work in LEO (Low earth orbit) and usually flight over the SGS twice per day.

In the demand of getting signal as comprehensive as possible, people need to distribute SGS around the earth. This is nearly impossible because of boundary of nations and cost for building, operating and maintaining. The group of sharing private SGS seem to be a good solution. Individual owning SGS (so called Host) could join a network of sharing and using SGS. The requirements (bandwidth, rating, durability…) should be established when they join the network. People who wants to get signal from satellites (so called User) could match their requirements to suitable available SGS.

There are lots of rising private company in space (SpaceX, Blue Origin, Sierra Nevada Corporation…) investing more in satellites and space commuting.

The project includes steps

1. Doing comprehensive literature research on space engineering, spacecraft dynamic and satellite communicating.

2. Constructing azimuth and elevation rotational structure. Design and building the mechanical structure of universal-mounting rotary antennas. Figuring out the optimal solution for electrical system and design. Programing a software with graphic user interface helping people to control structure manually and automatically.

3. Observing satellites broadcasting signal using SDR with suitable antenna. The system should adapt with many frequencies

4. Evaluating the performance and accuracy. Comparing with SVOM project if possible.

5. Finalizing and writing report.

Description:

In the step one, we need to do research on previous relating problems to find the similarities for boosting the process. We will evaluate the demand of using SGS based on statistic information of satellites launched or going to be launch about: working frequencies, orbits, communicating and life time. The purpose of job is figuring out which suitable antenna and LNA we should use and economic benefit in the future. We need to understand the basic of spacecraft dynamic for and orbit studying for getting familiar with space positioning.

The work load in step two is very heavy. Firstly, we need to design a suitable structure which could be carry the universal-mount responsibility which means we want to mount as many kind of antenna as possible. The reason is about the cognitive radio will work with many frequencies based on specific purpose, so the antennas must be suitable. The mechanical structure will allow the oriented antenna rotating in both azimuth and elevation axis. Secondly, the system requires appropriate motors and driving system as well as high precision electrical system. To manipulate this rotational system, we need to program a software running on computer to allow it working in both manual and automatic mode. The structure is expected to work outside with wind and rain resistance.

We are currently working in this step and photos below are our result so far.

In step three, we will work with SDR device which allows wide range frequency varying. Using tool call GNU radio, it can be easily manipulated via block diagrams similar to Simulink. This stage will happen paralleling to the end of step two because while working with GNU radio, it will contribute some ideas for the software. The general idea of this is input the LTE information of satellite and its working frequency, the rotary structure will point suitable antenna toward and keep tracking this satellite.

For evaluating the performance of system, there are two goals are established: high accurate tracking system and fluent switching frequencies. Dr. Hien, who is our advisor, is coordinating a project called SVOM in University of Paris Diderot, based on their plan, French site will allow us to operating their SGS, which is an opportunity for us to figure out the results.

In the final step, we will summarize and write the report of the progress of this project. We will point out some important experience to develop later relating projects.

Outcomes:

Hardware: 2 axes rotational system with universal mount for satellite tracking purpose and its controller working in both manual and automatic mode

Software: A program interfacing with SDR for frequency switching and signal processing.

Paper:

. Constructing an universal mount rotational system for satellite tracking

. Satellite ground station using SDR

In conclusion, in Vietnam, it is not only a new project but also advanced. Being involve in this, we are going to take a big challenge because of the constraint of budget and time. However, the successful project will not only gain big opportunities for commercial benefits but also spark a light on space engineering research in VGU.

Timeline

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| October 21st , 2018 | December 1st , 2018 | Literature review and planning for the structure |
| December 6th, 2018 | April 29th, 2019 | Building rotary system |
| February 1st, 2019 | May 29th, 2019 | SDR research |
| June 1st , 2019 | August 15th, 2019 | Evaluate the model |
| August 20th, 2019 | October 1st, 2019 | Complete the report and papers |

Budget plan

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| --- | --- | --- | --- |
| Item | Estimated cost | Request funding | Note |
| Aluminum frame and accessories | 6.000.000 VND | 6.000.000 VND | **Already paid in advance**  This is used for constructing the frame on ground station. |
| Aluminum sheet | 3.000.000 VND | 3.000.000 VND | **Already paid in advance**  Aluminum sheet (6061 type) is used to fabricating parts of rotating structure. |
| Motor drive system (with controllers) | 8.000.000 VND | 8.000.000 VND | **Already paid in advance**  Harmonic and worm gear drive are for capacity of high load and precision. |
| Main controller | 2.000.000 VND | 2.000.000 VND | Proposed to use the MSP432 launchpad or similar device which can provide real time calculation. |
| PCB manufacturing and circuit components (power ICs, transistor, resistor…) | 3.000.000 VND | 3.000.000 VND | Some PCB would be made for attaching the main controller to connecting many peripherals. |
| Wire and connector for cable management | 1.000.000 VND | 1.000.000 VND |  |
| Parabolic antenna and Yagi antenna | 10.000.000 VND | 10.000.000 VND | Based on market research, one 3m parabolic antenna (around 30dBi) has price of nearly $300 and one yagi is about $50 |
| LNA filter, SMA, RF accessories | 2.000.000 VND | 2.000.000 VND |  |
| Manufacturing | 10.000.000 VND |  | Will be proposed to use CNC machines in GPEM labs |
| Labor | 60.000.000 VND |  | Brief estimate based on general working hours of team members |
| Misc (screws, nuts, spray, pulley, bearing, wheels, drills…) | 2.000.000 VND | 2.000.000 VND | **Already paid in advance** |
| Total | 107.000.000 VND | 37.000.000 VND | We already paid 19.000.000 VND in advance to start working seriously on this project. |

Academic supervisor

I have reviewed this project description and projected budget, and I support this undergraduate research grant request.

*Supervisor’s signature date*

**ACADEMIC RESEARCH**

The proposed undergraduate research project is supported by the following research grants solely or jointly administered by me (*leave blank if not applicable)*:

*Supervisor’s signature*

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| Grant title: |
| Principal Investigator: |
| Project number: |
| Source of funding: |

**DO NOT WRITE BELOW THIS LINE**

(This part is filled in by the Chair of the Evaluation Committee)

*Comments:*

*Decision*:

*Funded amount:*

*Date:*

*Signature:*

*Name:*

Appendix