Results and Future Perspectives of the 2nd Mission Idea Contest

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Keywords: mission idea, contest, nano-satellite, application

Abstract As the number of nano-satellite developers has increased rapidly, the roles of micro/nano satellites have grown from an educational purpose into important scientific or practical purposes. In order to facilitate the exploration of novel applications using nano-satellites, the 2nd Mission Idea Contest for Micro/nano Satellite Utilization (MIC2) was organized. In this paper, an overview of MIC2 is given, including requirements, evaluation criteria and regional coordinators. Secondly, the results of MIC2 are examined with post-MIC2 activities. The effectiveness of MIC2 is considered, followed by a discussion on future perspectives and sustainablity of the contest.

1. Introduction

Nano-satellite technology development first started as either an educational or research tool primarily in universities and has spread rapidly across the world and found many practical applications. [1] Although micro/nano satellites cannot perform the same level of work as complex spacecraft because of limited power and room, there are many missions that can be made with micro/nano satellites. In order to facilitate the exploration of novel mission ideas using nano satellites, the Mission Idea Contest (MIC) was established in 2010. MIC has provided aerospace engineers, college students, consultants, scientists and anybody interested in space with opportunities to present their creative ideas and gain attention internationally. The team who initiated the contest intended to stimulate as many people as possible around the world to consider the potential applications for nano-satellites in the belief that nano-satellites will open a door to a new facet of space exploration and exploitation.[1] Fig.1 shows a group photo taken at the final presentation in the occasion of UN/Japan Nano-Satellite Symposium held in Nagoya, on October 10, 2012.

Fig. 1 Finalists, Semi-finalists, Reviewers, Coordinators, Supporters of MIC2

2. Overview of the Second Mission Idea Contest (MIC2)

2.1 Objective

The objectives of the 2nd MIC were: 1) to encourage innovative exploitation of micro/nano satellites to provide useful capabilities, services or data; and, 2) to contribute to capacity building in space science, applications and engineering. After the MIC1, regional coordinators reported that MIC was helpful in capacity-building and that more attention should be paid to educational considerations. Hence, it had been decided to include capacity-building as the second objective of the MIC2. [2]

2.2 Requirements

The MIC2 offered two categories, Category 1: Mission Idea and Satellite Design, and Category 2: Mission Idea and Business Model. Applicants of Category 2 were provided various "cost vs. performance" models for each segment, such as satellite bus, mission components, launch, and ground operation. [3] Requirements and evaluation criteria on Category 1 and 2 for MIC2 are shown in table 1.

Table 1 Requirements and Evaluation Criteria for MIC2

	Category 1	Category 2
require-ment	Exploitation of nano-satellite(s) <50 kg	Proposal of business plan using micro /nano-satellite(s) <50kg
Evalua-tion Criteria	**Originality (50 points)** -Novel mission concept not yet realized or proposed, or a new implementation of an existing capability or service (25) -Impact on society (25) **Feasibility (50 points)** -Technical (20) -Programmatic (cost estimate, development schedule, infrastructure requirements) (15) -Operational (description of ground segment and communications architecture, e.g., planned use of existing infrastructure) (15)	-Key concept and impact on society and environment (40) -Business model structure (5W2H: who, to whom, what, when, where, how, how much). (15) -Business feasibility (15) -Logistical feasibility based upon the cost model provided by the organizer. (15) -Risk Analysis (15)

2.3 Contest Steps and schedule

In July, 2011, a world-wide call for ideas was issued and the information had been disseminated througout the world through more than 30 Regional Coordinators who had been appointed for the MIC2. The contest had two steps. The first step was the selection of finalists by abstract submission, and the second step was oral presentation in the UN/Japan Nano-satellite Symposium where winners were selected among the finalists. The schedule of MIC2 is shown as table 2.

Table 2 MIC2 schedule

July 19, 2011	First Announcement
Sept 2011 – April 2012	Regional seminars
May 1, 2012	Abstract Deadline
July 1, 2012	Announcement of Finalist
Sept 1, 2012	Final Paper Deadline
Oct 10, 2012	Final Presentation at the UN/Japan Nano-Satellite Symposium

2.4 Regional Coordinators

Regional coordinators played significant roles in pursuing the contest. They disseminated information and facilitated potential applicants in their region to develop ideas and submit abstracts. Regional seminars or MIC2 introductory presentations had been organized in 24 countries, namely Peru, Brazil, Lithuania, Taiwan, Saudi Arabia, Japan, Kenya, Turkey, Singapore, Belgium, Egypt, México, Bulgaria, Nigeria, Korea, Spain, Guatemala, Ghana, Namibia, Tunisia, Germany, Philippines, Venezuela and South Africa. We should point out that approximately 60% of the applicants heard about the contest through the Regional Coordinators and Regional Seminars organized by them. [2]

Fig.2 shows examples of regional seminars.

Fig.2 Examples of Regional Seminar (from left, Namibia, Brazil and Tunisia)

3. Results

In the MIC2, 72 applicants from 31 countries submitted abstracts. The number of applications increased by 10 from 62 and the number of countries increased by 7 from 24, compared to the MIC1. 10 finalist teams and 9 semi-finalist teams were selected and invited to Japan to make a presentation as a part of UN/Japan Nano-satellite Symposium in Nagoya, Japan on October 10th, 2012 [4].

Among the 72 applicants, 54 teams were student teams. In other words, 75% of the applicants were student teams. Although it is impossible to compare with MIC1 as there is no data of student teams in the MIC1, the ratio can be said to be quite high.

Fig.3 indicates country distribution of MIC2 participants.

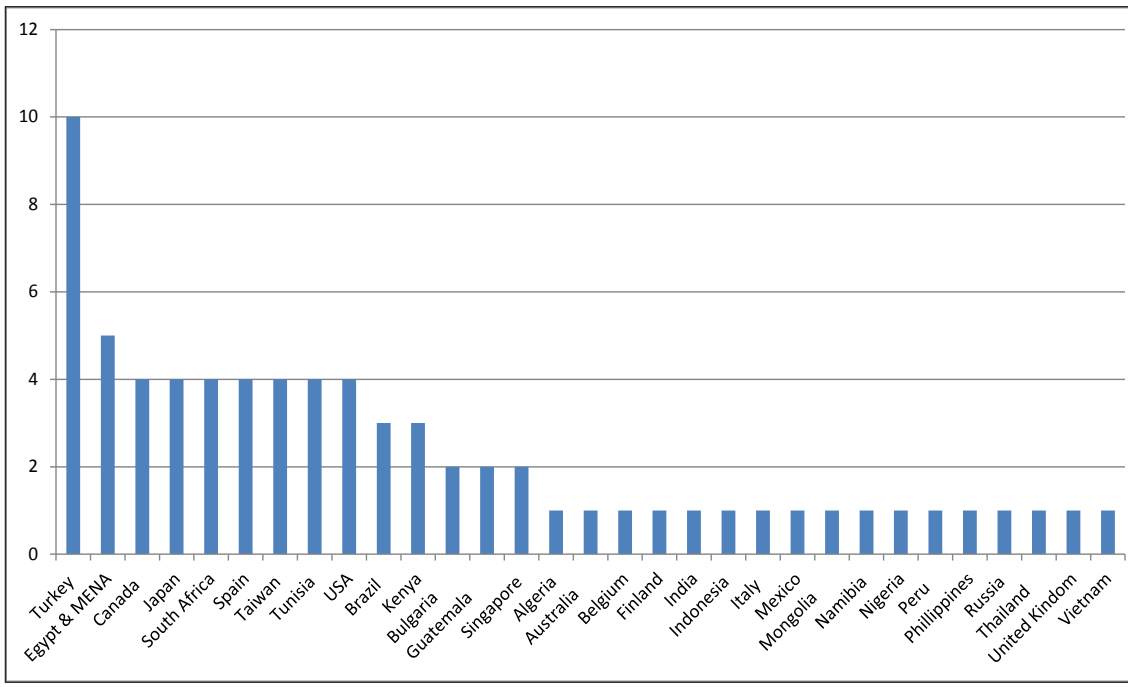

Fig.3 Country distribution of MIC2 participants

Turkey's contribution is outstanding, and Egypt, Canada, Japan, South Africa, Tunisa, USA, Brazil and Kenya submitted more than 3 abstracts. Applicants were permitted to submit papers to the MIC office directly over the internet, but the regional coordinators from the regions that made the biggest contributions often contacted the MIC office before the abstract submissions were due, to ask for clarification of the evaluation criteria or to convey questions from potential applicants.

Fig. 4 shows the regional distribution of participants in MIC1 and MIC2.

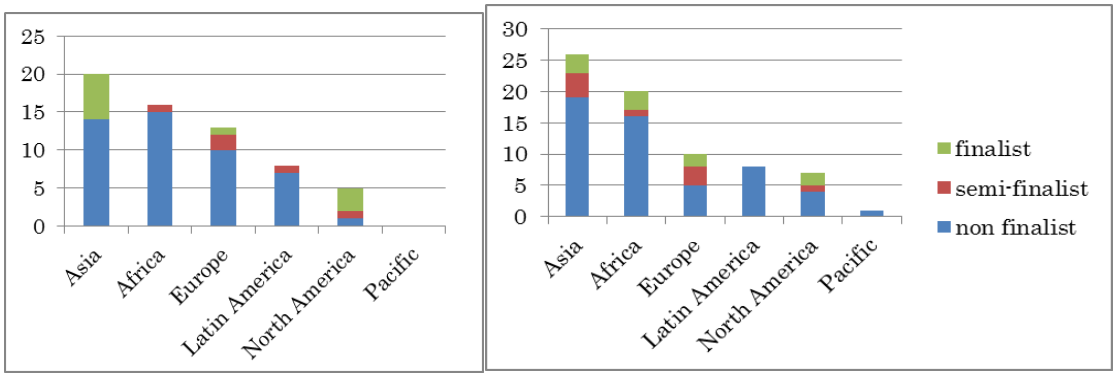

Fig. 4 Regional Distribution of Participants (Left: MIC1, Right: MIC2)

The biggest group of the regions is Asia. It is understandable as the contest was held in Japan, but it should be noticed that the next biggest group is Africa. Also, the African contribution to the MIC2 expanded in quantity and quality, compared to the MIC1. In the MIC1, only one team was selected as a semi-finalist, but in the MIC2, two teams were selected as finalists and one team was selected as a semi-finalist.

4. Post MIC2 Activities

It would be effective to inquire about the possibility of realizing the mission ideas in order to uncover the impact on society of the MIC2, because realization of a new mission idea certainly would make a difference in the world. Hence, post-MIC2 activities of the finalists and semi-finalists have been investigated. Simple questions on their post-MIC2 actvities have been asked to them as follows:

1) Do you think you can realize your mission idea in your country?
2) If yes, did you take any actions?
3) If No, what would help you to realize the mission?

Ten finalists and five semi-finalists answered among 19 selected teams by personal email, and all comments were shared on the MIC Facebook page [5]. There is not enough space for examining all 15 teams in this paper, and we will use some missions as typical examples.

The following five points seem to be helpful in attempting to sketch out the current status of each team.

1) seeking technical solution (shown as T)
2) seeking funding (shown as F)
3) modifying mission ideas (shown as M)
4) they don't believe that they can currently realize the mission at their countries (shown as NG)
5) starting project activities (shown as SP)

The results of the investigation using simple questionares are summarized as table 4.

Table 4 Status of Mission Ideas selected as finalists and semi-finalists in MIC2

category	Title	Country	Status
1	SOLARA/SARA: Solar Observing Low-frequency Array for Radio Astronomy/Separated Antennas Reconfigurable Array	USA (1st place)	T, F
1	AlbertaSat-1: Greenhouse Gas Monitoring for Industrial and Environmental Improvement	Canada (IAA award)	F, M
1	ADR Mission with small Satellite	Italy	T, F, M
1	Nano-satellite constellation collecting global pre-earthquake signals for space-borne early earthquake detection	Singapore	F
1	Project of Micro-Satellite Constellation for Earthquake Precursor Study	Japan (2nd place)	F, M
1	The OuterNet: A novel satellite communication relay constellation	South Africa (student prize)	T, F
1	SWIMS - Short Wave Infrared Maritime Surveillance	UK	F, M
2	Thermal Infrared Remote Sensing Using Nano-Satellites for Multiple Environmental Applications	Philippines (2nd place)	NG, T, F
2	Underground and surface water detection and monitoring using a microsatellite.	South Africa (1st place)	NG, T, F
2	Global Tracking System	Egypt	NG, M
1	Droplet Stream Orbital Debris Remediation	USA (semi-finalist)	SP, F
1	SofiaUniversitySAT (Small Communication Satellite Mission for Enhancement of Antarctic Investigations)	Bulgaria (semi-finalist)	SP, F
1	IDEA: In-situ Debris Environmental Awareness	Japan(semi-finalist)	SP, F
2	Satellite real time monitoring of water flood and quality in Tunisia	Tunisia (semi-finalist)	T, F
1	Laser-Assisted Rain Control Constellation	Thailand (semi-finalist)	T, M

40% of respondents are seeking technical solutions, which means that they are not ready to realize the mission yet. There are two types in the group. The 1st group includes those who currently do not have the technology in their organization or their country. Teams from Phillipines, South Africa and Tunisia belong to this group. The 2nd group includes those who simply need to make further research and verification before building a satellite to realize the mission. SOLARA/SARA presented by a Ph.D student of Massachusetts Institute of Technology (MIT), the 1st place idea in the Category 1, is a typical example. The mission is complex, and the authors think that it will take several more years before being ready to fly.[5]

87% of respondents replied that they are seeking funding. Teams from Egypt and Thailand did not mention it, but it is not because they had sufficient financial resources, but because they do not think they can currently pursue the projects. Hence, the financial problem seems to be a common problem.

40% of respondents answered that they are modifying the mission ideas, designs and implementation plans. Reviewers' comments and further research seemed to make them realize how to be more realistic or to find the better way. The Canadian student team, the winner of the IAA Environmental Award, proposed "AlbertaSat-1: Greenhouse Gas Monitoring for Industrial and Environmental Improvement." In the beginning, they estimated the cost at $300,000, but after realizing the difficulty in fund-raising, they re-designed AlbertaSat-2, and the cost decreased to $100,000. [5] Also, a Japanese team that proposed "Project of Micro-Satellite Constellation for Earthquake Precursor Study,"

the winner of the 2nd place in the Category 1, is modifying the satellite design upon reviewers' feedback at the Q&A session in the MIC2 final presentation.

3 teams (20%) from Egypt, Philippines and South Africa don't believe that they can currently realize the mission in their countries. It is an interesting coincidence that all three teams are finalists of the Category 2, and all teams are composed of students. The Tunisian team was selected as semi-finalists for Category 2, but they do not seem to give up realizing the mission as they are starting to recruit promising students to work for the mission and seek collaboration with advanced universities in satellite engineering in Europe.

On the other hand, 3 teams (20%) from USA, Bulgaria and Japan already started project activities to realize the mission idea. The Japanese team which proposed "IDEA: In-situ Debris Environmental Awareness" started to build a satellite with a small budget that would not enable them to purchase necessary components. [5]

5. Discussion

5.1 Positive effect

5.1.1 Credibility and high visibility

For participants, especially for finalists and semi-finalists, MIC is a good opportunity to get international attention and prove the excellence of their mission ideas. The certificate will give participants good academic records. In addition, full papers will be published as a book by the IAA. Of course, it would give them confidence to be selected from many teams. The confidence will encourage and energize them to persuade potential sponsors and collaborators.

5.1.2 Collaboration and network

There were collaboration and networking opportunities through MIC2. For example, at the final presentation, Italian finalists met a Canadian coordinator who led them to a chance to work with a Canadian university for realizing a subsystem of "ADR Mission with small Satellite."[5] Also, an Indian semi-finalist team which consisted of undergraduate students had a chance to be supervised by a Guatemalan coordinator when they rewrite for publication. There will be many potential collaborative opportunities through the network in the future.

5.1.3 Capacity building and support

Participating in the MIC does not require any costs and the MIC gives participants good opportunities to learn whole satellite systems by developing mission ideas. Hence, it provides good educational opportunities to students. Especially, for those from regions that have not had capacity to build satellites, the MIC gives motivation, as participants have a chance to be reviewed by experienced experts, which would be difficult for them to have without participating in the MIC.

In order to improve the educational aspect in MIC2, several extra efforts had been made. For example, short comments to the all participants were given by reviewers after the 1st selection by abstract. A certificate was issued to certified applications. In addition, external support was given to applicants. Analytical Graphics, Inc., Princeton Satellite Systems and Teaching Science & Technology, Inc. supported applicants by licensing software or sponsoring training courses.

5.2 Common problems for realization of actual mission

5.2.1 Lack of funding resources

It is not a surprise that the MIC2 participants face financial difficulties in realizing their mission ideas due to financial problems. Even if some funding were given, they would need more. Student teams seem to have more difficulty to raise funding.

5.2.2 Lack of members

A student team is difficult to maintain for further development as the members graduate and cannot continue to work on the project. Taking over the project is possible, but it is not easy to keep the same level of motivation and knowledge. Technology transfer to new students is not easy. In some regions like Tunisia, they need to educate students to be able to design and build satellite first at their university. Thus, what they need to do first is to recruit promising students who will be able to work for satellite projects in the future.

5.2.3 Technical difficulties

Developing a mission idea and designing a satellite which makes the mission possible are different. There is also a huge gap between designing and building a satellite. In each process, participants will face technical difficulties. Before starting, there is possibility that mission equipment is not available or not possible for small satellites.

6. Future perspectives

6.1 Reasons for continuing MIC

Before discussing the future perspectives, we would like to consider why MIC should continue, because the reasons would lead us to the direction that we should go to. There could be several possible reasons.

Firstly, MIC provides good training opportunities as capacity building program. As MIC does not require any financial resources to apply, students in less-developed countries can participate without hesitation, and can get support from regional coordinators in their mother language.

Secondly, MIC offers a chance to involve professional researchers and scientists who are not working in space fields through working on mission design using micro/nano satellites. As a micro/nano satellite provide more limited power and function than big satellites, a trade-off has to be carefully considered and decision-making should be made not to damage the meaning of the mission. Only researchers who are eager to get the data for their research knows the margin of concession to get meaningful data. If the mission equipment were too big to place on a satellite weighing 50 kg, the mission would be impossible.

Thirdly, the MIC can function as catalyst which can make a difference in the real world. With the MIC, many people including students start to think what they need or want, and what they can do to achieve the goal using micro/nano satellites. Through participation in the MIC, needs/wants and solutions are considered in deeper level.

6.2 Tackling the obstacles for realization

It would be important to consider how to tackle the obstacles to realize mission ideas because if we knew it, we would be able to redesign the requirements of MIC to facilitate developing more feasible missions.

As it has been seen, funding problems are everywhere. Without funding, it would be difficult to realize the mission idea. It is difficult to make the mission idea happen only by satellite developers making efforts. Diverse efforts from many people who have different expertise would enable the team to involve sponsors and investors. Of course, it would be difficult to seek them, but there are some available funding resources. It is possible to introduce funding schemes, but it takes time and preparation to apply for such funding. For example, the "Science and Technology Research Partnership for Sustainable Development Program" (SATREPS), a Japanese government program that promotes international joint research targeting global issues, can support some proposals which would contribute to solving global problems. It provides about $3M for joint research for 3-5 years.[6] There must be other funding programs in other countries, too. Student teams would need to involve professors as many funding programs do not allow students to apply.

Follow-up activities would be helpful in realizing their mission ideas. MIC office can make their activities visible through the internet. Social networking service would be a convenient tool to share the information with those who are interested. It also could function to collect donations for the projects.

7. Conclusion

Through participating in the MIC2, many applicants from all over the world had opportunities to consider and present their unique mission ideas using micro/nano satellites. The MIC2 contributed to creating networks and collaborative opportunities as well as capacity building. Investigation of Post-MIC2 activities clearly shows that participants have difficulties in realizing their mission idea despite their desires and confidence. The contest provides good opportunities for capacity building and international collaboration. Participants were pleased to join the contest, and many potential applicants have asked about the next MIC. It is good, but it would be more meaningful if the mission ideas can be realized as real satellite projects. Hence, we would like to make efforts to increase the number of realized missions and inspired missions in the future.

Acknowledgement

The MIC2 was supported by a grant from "Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST Program)." The student prize of MIC2 was sponsored by Gesellschaft zur Förderung des akademischen Nachwuchses (GeFaN). International Academy of Astronautics (IAA) sponsored to publish MIC1 book, and also offered IAA award for MIC2.

We wish to thank the MIC2 finalists and semi-finalists who contributed to this paper: Mary Knapp, Masashi Kamogawa, Morné Roman, Edgardo Macatulad, Jordan Backs, Mike-Alec Kearney, Akira Doi, Ragy Ismail, Mohamed Alrefaie, Vu Bui, Marcello Valdatta, Niccolò Bellini, Davide Rastelli, Nil Angli, Thomas Joslyn, Plamen Dankov, Kamel Besbes and Ravit Sachasiri. We also aknowledge that Larry Reeves, a Canadian MIC coordinator, helped to improve the quality of the paper as proof reader.

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