In the name of Allah

Guidelines for Remote Sensing-Communication Class of the 10th International Iran CanSat Competition 2024

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1 INTRODUCTION

The 10nd International Iran CanSat Competition contains two classes:

1. Remote Sensing-Communication
2. Scientific-Exploration

Iran CanSat competition provides an opportunity to design, build, and complete the flight mission of CanSat for teams from all over the world. CanSat is a small satellite integrated within the scale of a drink can. Teams can participate in one or both classes. Guidelines for the first class are presented in this document.

1-1 Mission Description

The mission of the Remote Sensing-Communication CanSat is to measure environmental data such as temperature, humidity, and pressure, as well as to take images and send them to the ground station. The mission defined in this competition is data acquisition and image processing by artificial intelligence in the field of agriculture, environment and crisis management. In this mission, CanSat is released over ground targets and it must measure the area of target and detecting their colors by using image processing algorithms. In this regard, detecting targets and their colors must be applied in a semi-automatic or automatic manner.

Note: The CanSat landing mechanism must be designed in such a way that it lands the payload at the closest point to the ground target area.

The teams should measure the distance between the target symbols and their surrounded area (the area within the sides formed by connecting the adjacent vertices) using image processing algorithms performed on the captured images. image processing algorithms can be done on the CanSat or on the ground station.

1-2 Mission Scenario

Note that the critical and preliminary design must be compatible with the CanSat competition scenario as follows:

1. CanSat is turned on and placed in releaser. Releaser is used for ascending and releasing CanSats and it is provided by competition organizers
2. The ascending CanSat collects mission data such as temperature, pressure, and so on and transmits them to the Ground Station in real-time.

   Note 1: each team should develop and have its own Ground Station.

3. CanSat is released after reaching the specified altitude of the competition. CanSat must also collect and transmit data during the release phase.
4. The descending CanSat must capture images from desired area on the ground using its camera.
   These targets must be identified using the images and reported to the ground station during or after the flight.
   The area of targets and their colors should be automatically reported by the CanSat.
5. CanSat should have a safe landing using the recovery mechanism after release.

A safe landing at the nearest distance within the area of targets should be considered, should be given to Considering cross-wind or external chaos.

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6. After reaching the target position, CanSat stops and declares its presence so that it can be tracked.
7. After finding CanSat, it is turned off and the mission is over.
8. Assessment of the results is carried out using observations by the referees.

Figure 1 shows the schedule of the competition day.

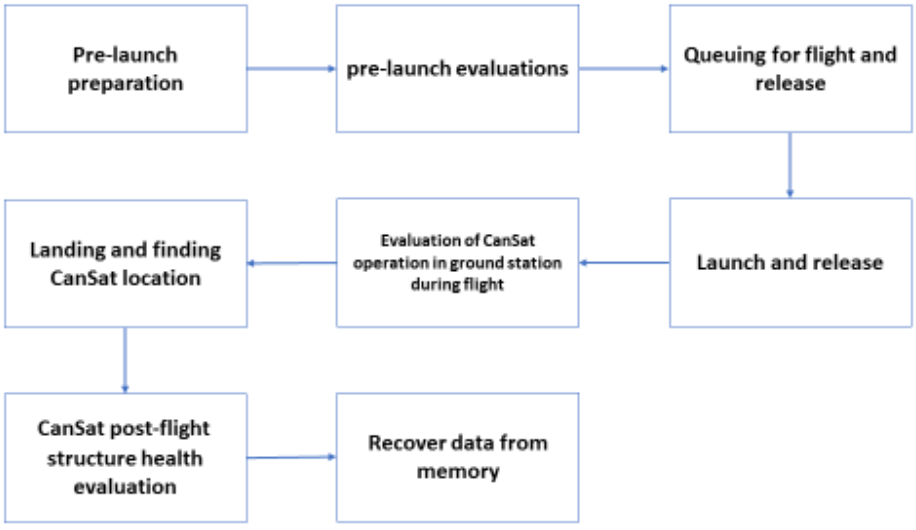

Figure 1: Schedule of the competition day

Note 2: Using the Internet platform to exchange data between the CanSat and the ground station in each stage of the mission (optional) will have extra scores depending on the quality of the work.

2 OPERATIONAL AND FUNCTIONAL REQUIREMENTS

Capturing at least three images during the CanSat descent and measuring the area of targets and detecting their color.

1. Measuring parameters include:

   Mandatory:

   - Enclosed area of targets

   - Detecting their colors (presenting the area of targets by inserting the area and color on the image)

   - Air pressure

   - Temperature

   - Height

   Optional (with extra scores):

   - Humidity

   - Local or global position of the ground targets

   - Air condition

   - Heading

   - Or any other parameters approved by the referees' committee

2. Sending the image to the ground station and processing it
3. Accurate and on-time measurement of parameters
4. Sending measured parameters in the requested data format immediately after the measurement
5. Valid and reliable telecommunication between Ground Station and CanSat without interference
6. Updating data rate at least every second
7. Recovering/Retrieving recorded data from memory after the operation
8. Appropriate graphical display of received and analyzed data immediately in Ground Station
9. Quality and resolution of transmitted and stored images:
   - Images should be completely transmitted in digital format
   - At least three images should be transmitted at the time of descent

- The images must be compressed using compression methods

2-1 Dimension and Mass Requirements

1- The maximum diameter of CanSat should be 66 mm

2- The maximum height of CanSat should be 115 mm

3- The maximum mass of CanSat should be 350 gr

*Disobeying the above-mentioned rules will result in score penalties or prohibition from the competition.

2-2 Table of Technical Requirements

Technical requirements and their approval methods in the conceptual and preliminary design phase of CanSat are categorized in the following table as an example:

code	requirement	source	Physical specification	priority	Approval method			
					Design review	test	analysis	control
1	The mass of CanSat must be less than 350 gr	competition	structure	high				✓
2	In classical class, CanSat must fit inside a standard soda can (115 mm height and 66 mm diameter)	competition	structure	high				✓
3	CanSat must be compatible with the ascending system (during ascending, acceleration changes in the design must be considered)	competition	Structure, recovery	high				✓
4	CanSat must land safely to the ground(conditions of descending, acceleration changes, and landing must be considered in design)	mission	recovery	medium		✓		
5	The use of toxic and flammable materials is not allowed in the design of CanSat	competition	structure	medium		✓		
6	CanSat must obey the RF regulation	competition	Telecommunication	high	✓		✓	
7	CanSat must measure atmospheric parameters	mission	payload	high		✓		
8	CanSat must collect data related to atmospheric sensor or data in payload such as temperature	mission	Data management and command	high	✓			
9	CanSat must transmit GPS data, sensors data, and CanSat health status information	mission	Transmission/teleco-mmunication	medium	✓	✓		

10	CanSat must be in operational status for 90 minutes	Operation concept	power	low		✓	✓	
11	CanSat must be resistant to operation load (launching phase, phase of releasing before parachute, releasing with a parachute, and landing)	Operation concept	structure	medium		✓	✓	
12	Each CanSat must be equipped with a beacon system to declare its presence at the location	mission	payload	high			✓	

3 COMPETITION RULES

1- CanSat teams consists of 3 to 5 people and a supervisor can be introduced separately in the registration form.

2- The representative of each team for correspondence is the head of the team and all correspondence is done through the supervisor.

3- The change of team members is done at the request of the team leader, and this change can be made before the final teams are announced (declaration of the results of the detailed design and construction report).

4- All opening parts and connections must satisfy the dimension of CanSat class before release.

5- The space occupied by the recovery system (parachute) is not included in the above-mentioned limit. A cylindrical space with the same diameter as the CanSat diameter and a height up to 10 cm above the CanSat can be used for the recovery system. Note that, the recovery subsystem mass is included in the CanSat mass.

6- Competition organizers are responsible for providing the means for launch and release of the CanSat which satisfy the dimensional requirement.

7- CanSat shall conform to dimensional constraints of their categories and fit in the release system without causing any interference to the performance of the release system. Note that, the CanSat must comply with the radio frequency regulations in their design and development.

8- The final product shall be in conformance with the Critical design and manufacturing report (CDR). Any difference between these two may lead to score penalties. Significant dissimilarity of the CanSat by the CDR report will lead to disqualification and elimination from the competition.

9- Considering the goals of the competition, each team should put their effort into gaining knowledge and experience in the design and development of a system. Therefore, the use of any commercial off-the-shelf (COTS) modules/equipment as a CanSat total subsystem is not allowed. COTS modules can be used as constructive parts of subsystems.

10- The use of toxic and flammable materials is not allowed in the design of CanSat, and on the competition day. In case of incorporating any hot/hazardous parts in the CanSat design, the organizer team must be informed and their confirmation must be obtained well ahead of the competition time.

11- CanSat shall operate autonomously and no command from Ground Station is allowed to be sent during the operation scenario (telecommand is not allowed).

12- The recovery subsystem must be designed with a descent rate equal to or less than 5m/s.
13- After landing, the CanSat mechanical and electrical mounting integrity of all subsystems including mounting connections, structural components, and battery connections must be maintained. Fulfillment of the above conditions will be part of the evaluations.
14- The electrical power supply subsystem of the Cansat must provide the required power for the entire operation time, including the time needed to recover after landing and at least 60 minutes before the operation.
15- The team name shall be printed on the CanSat to help with the identification of the CanSats. Also, a colored ribbon, which is visible from far away, must be applied axially to the surface of CanSat.
16- Each team shall design its own Ground Station. As ground station design significantly affects the presentation of CanSat functionality, teams should pay enough attention to the design of the Ground Station.
17- Considering the tight schedule on the operations day, each CanSat will only have one release chance, and the results and operation during the release will be used for evaluation.
18- After landing and recovery, each CanSat will be evaluated by the referees, data will be recovered, and CanSat will be given back to the team representative.
19- For the image processing score, the referees will evaluate the captured image and the corresponding calculated area of each team.

3-1 Radio Frequency Regulation

The communication frequency of the CanSat with the ground station should be in the range of amateur radio frequencies of: 430-440 MHz or 2400 to 2450 MHz. Transmitted power shall be less than 20 dBm (or 100 mW). Teams shall report their utilized operating frequency and transmitted power in their CDR. Teams must be ready to apply slight changes in their operating frequency in case of interference with other teams or the launching system occurs. After the CDR report and confirmation of the frequencies, affected teams would be notified of these necessary changes in the frequency band. Also, if using any network-supported communications module, each team should choose a unique random NETID/PANID code. The network settings including NETID/PANID code must be reported in CDR.

3-2 Data Format

Data packages should have the following formats respectively (read from left to right), and delivered to the referees on flash memory or CD. The comma (,) should be used to separate data pieces. File extension should be .CSV or .TXT. This order of data storing is known as alpha recovery.

The order of storing data (alpha recovery) is (read from left to right):

<Abbreviation of team name with at least three letters>, <Mission time since release>, <Data packet count>, <Longitude>, <Latitude>, <height>, <Temperature>, <Pressure>, <Humidity>, <UV indicator>, <Other optional data>, <CR>

Example:

ARI, 3.37, 153, 35.423, 52.487, 121.2, 25, …

4 REPORTS

Each team should provide three technical reports. Reports shall be following the predefined format and schedule explained in the following list:

4-1 Preliminary Design Review (PDR)

Objective:

- Understanding design requirements and constraints
- Understanding essential subsystems
- Understanding communication subsystems
- Understanding the design process
- Planning financial, time, and human resources

Content:

- Explaining design requirements
- Defining and explaining subsystems to address the design requirements
- Preparing scenario and operational concepts
- Team introduction
- Presenting configuration and layout
- Presenting subsystems' specifications
- presenting architecture and relation between system and subsystem's components
- Introducing the used software algorithm
- Fundamentals of theoretical and scientific design
- Test design and product standardization
- Studying and statistical matching
- Product development schedule (Gantt Chart)
- Financial and human resources budget

4-2 Critical Design and Manufacturing Report (CDR)

Objective:

- Presenting design with details of components, modules, subsystems, and systems

- Presenting the relation between designed subsystems

- Presenting functional quality test results for components and subsystems

- Presenting product features based on the design specification and test results

- Providing details and capabilities of the Ground Station

- Providing an operational checklist from the beginning of the launching moment to the end mission

- Providing financial, time, and human resources budget

Content:

- Providing concept of operation (CONOP), operational requirements, and aging profile

- Providing details of critical design of subsystems; providing changes and improvements of preliminary design

- Proving coverage of design requirements by designed subsystems

- Presenting test results and verifying operational/functional quality test

- Presenting the designer's prediction of system operational capability by providing measurable statistics and data

- Details software algorithm

-Presenting the architecture and configuration of the system and relationships between the subsystems

- Details of the design and setup of the ground equipment

- Providing details of the overall operation phases

- A preliminary plan of pre-launch operation

- Updating human resources and financial budget

- Updating the initial scheduling (Gantt Chart)

4-3 Post Operation Report

Objective:

- Evaluation of system performance compared with design objectives

- Estimating operation success

- Analyzing the function of Components and Systems

Content:

- An overview of the operational objectives of the plan

- Comparison of operating scenarios with the operations performed

- Providing raw data as well as the results of analyzing these data

- Introducing the strengths and weaknesses of the design and providing solutions for improvement