



**HETEROGENEOUS SWARM SIMULATION
COMPETITION SPECIFICATIONS**

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HETEROGENEOUS SWARM SIMULATION COMPETITION

COMPETITION SPECIFICATIONS

1 PURPOSE

The purpose of the Heterogeneous Swarm Simulation Competition is to develop software and algorithms for the performance of defined tasks with more than one Unmanned Air and Ground Vehicles (UAV and UGV) under optimized target criteria based on task sharing, backup, and complementing each other. Within the scope of the competition, the subject of disaster and pandemic was simulated in a simulation environment, and a competition scenario was designed in which teams can deliver health services to patients using swarm systems in the fastest way in a city. With this competition, it is aimed to support people who are interested in swarm UAV and UGV systems.

2 CONDITIONS OF PARTICIPATION

Competition participation conditions are as follows:

- High school students, undergraduate, graduate and doctoral students or graduates of universities may participate in the competition individually or as a team.
- Teams will be able to receive sponsorship support from companies or private individuals.
- Teams should consist of a maximum of 8 people. Teams can only take 1 person as a consultant.
- Teams can be formed from a single school or can be formed as a heterogeneous team by bringing one or more secondary education / higher education students together.
- Along with the Preliminary Design Report, approved student documents must be submitted for students, and a certified document showing that they are lecturers / lecturers, research assistants or teachers for consultants.
- A member of a team cannot be found as a member of another team of the same competition.
- High school level teams must hire a mentor. The document stating that the person who will serve as the Consultant will fulfill the consultancy duties must be uploaded to the system together with the Preliminary Design Report with wet signature.
- Undergraduate, graduate students and graduate-level teams may recruit a lecturer / member or research assistant as a consultant.
- The consultant is required to upload the document that he / she will receive from the relevant institutions where he / she works as a teacher / trainer / academician, with the Preliminary Design Report.
- The consultant is obliged to send the assignment letter from the relevant education / training institutions to the TEKNOFEST Committee.
- In case of a change in consultant, they must notify the relevant TEKNOFEST Committee in writing. (This document is required to change consultants.)
- Transportation and accommodation support for the finalist teams is limited. The number of people to be supported will be notified to the teams later by the TEKNOFEST Competitions Committee.
- TEKNOFEST Competitions Committee has the authority to limit the number of members to be in the festival area. In case of limitation, information will be given by the committee.
- The competitors will be able to participate in the competition by reading and approving all the explanations about the competition and the participation conditions before applying.

Applicants to the competition are deemed to have accepted all of the above conditions.

The deadline for submitting the application form is February 28, 2021. Team information and contact numbers will be specified in the application form.

Applications will be made on the official website of the Aerospace and Technology Festival TEKNOFEST Technology Competitions (www.teknofest.org).

2.1 Contact

The following address will be used for questions about the competition: teknofestkarmasuru2021@googlegroups.com All technical questions required to prepare for the application will be answered via this address.

3 COMPETITION PLACE

3.1 Exhibition Hall

A hall to be allocated within the area to be determined within the scope of TEKNOFEST or a part of a hall will be used to prepare the teams and exhibit their projects to the visitors. In this area, a table and a chair will be reserved for each team to use. There will be 220V electricity access at each table.

3.2 Competition Hall

A screen will be allocated in the competition area so that the performances of the competing teams in the simulation environment can be watched by the audience. The relevant team member will explain the team strategy to the audience on this screen.

4 COMPETITION SCHEDULE

Date	Explanation
28 February 2021	Competition Application Deadline
05 March 2021	Technical Specification Publication
18 March 2021	Simulation Environment Release
30 March 2021	Question and Answer Meeting
04 May 2021	Preliminary Design Report (PDR) Deadline
11 May 2021	Announcement of PDR Results and Teams that Passed the Pre-Qualification
15 May 2021	Question and Answer Meeting
25 May 2021	Deadline for Video and Source Codes
05 June 2021	Announcement of Screening Results Based on Video and Source Codes
24 June 2021	Question and Answer Meeting
3 August 2021	Question and Answer Meeting
29 August 2021	Project Report Deadline
17-22 September 2021	TEKNOFEST 2021, Heterogeneous Swarm Simulation Competition

Q&A meetings can be held at T3 Foundation facilities, HAVELSAN facilities or through the HAVELSAN DIYALOG page (<https://diyalog.havelsan.com.tr/>). In addition to the course of the competition, the follow-

up of the development levels of the teams, and the sharing of opinions and suggestions with the teams about algorithms and software can be made with question-answer meetings.

5 COMPETITION TASK

Teams will accomplish the tasks that are defined in the scope of the scenarios of the simulation environment. Three sample scenarios will be shared with the teams after the introduction of the simulation environment. Competitors will be able to try the swarm algorithms they will develop through these sample scenarios. With the delivery of the video and source codes, it is expected to show the swarming algorithms under sample scenarios. Scoring will be done automatically by the simulation software. Detailed technical requirements will be announced in the technical specification publication in accordance with the competition schedule.

5.1 Scenario

A pandemic has been declared in the world and the number of cases has gradually increased. In order to minimize the pandemic effect and fight with the disease, all institutions and organizations are working with all their strength and it has been decided to benefit from the UAV and UGV swarms.

5.2 Task Demonstration

Swarm UAVs and UGVs will take part in the residential environment. The patient density map and patient status information of the residential environment are instantly shared with the swarm UAV and the UGV control center. Based on this information, it will be ensured that UAVs and UGVs can reach and serve people as soon as possible and decrease the pandemic spread rate.

5.2.1 Swarm UAV and UGV Control Center

The center is the unit where all the addresses and population information of the residential environment is available, the pandemic density map is kept up to date, and the health status of the people is monitored instantly. Through this unit, swarm UAVs and UGVs can be directed to the desired regions without human intervention for desired tasks.

5.2.2 Task Area

UAVs and UGVs assigned from the Swarm Control Center will go to the relevant regions and addresses.

- Medicine and food can be transported with swarm UAVs.
- With swarm UGVs, patients, medicines, food and beverages can be transported.
- In order to provide service to the most people in the task area as soon as possible, the elements of the swarm systems allocated for this task will operate optimally.
- Patients will be transported to the hospitals with the closest quota with UGVs.
- In the task area, there may be ruined buildings due to the disaster, and such areas will also need to be served.

5.2.3 Arriving at Addresses in the Task Area

- It is possible to reach the addresses communicated by the swarm management center by air or land.
- Obstacles (such as buildings for aircraft, traffic elements for land vehicles) should be avoided while reaching the duty zone.

5.2.4 UAV and UGV Stations

Stations are the regions where UAVs and UGVs are collected. Systems will be able to charge during their stay in these areas.

- UAVs can be deployed any number of times in this region.
- UGVs can be deployed as many times as desired in this region.
- There may be more than one of these stations in the residential area.

5.3 Additional Information

Swarm algorithms are expected to be generic. In this context,

- Algorithms will be able to optimally manage the desired number of UAVs and UGVs.
- UAVs will consist of quadrotors and helicopters.
- UGVs will consist of 2 and 4 wheel vehicles.
- There may be some traffic in the city.
- Depending on the number of patients, hospitals, addresses, etc. specified at the beginning of the scenario, teams will optimally use the fixed amount of UAVs and UGVs given at the beginning of the competition scenario.

Also,

- Arriving at addresses at any time and delivering the service earns points.

5.4 Task Environment

The task area can be a settlement of at least 2km x 2km. The settlement area will be detailed in the technical specification. The road and building models to be used will be shared with the sample scenario. The positions of all simulation elements may be different for different scenarios.

A generic helicopter, quadrotor, wheeled vehicle models and a control system will be provided to the competition participants. Teams will only be able to compete using these models. Participants will submit their heterogeneous swarm algorithms in MATLAB / Simulink, Python or C / C ++.

5.5 UAV and UGV System Technical Specifications

The vehicles to be used within the scope of the mission can operate in a swarm, fully autonomously without human intervention. Competitors should consider the dynamics of their vehicles when designing swarm algorithms.

In order to achieve task scenarios, all relevant payloads will be available on UAVs and UGVs.

Vehicles are able to sense position and speed information through their sensors and can share this information with the center.

6 PROJECT SCOPE

6.1 Activities to Be Performed

The teams will cover the following basic issues within the scope of the competition project:

- Determining heterogeneous swarm strategies,
- Development of software algorithms for the determined strategies,
- Evaluation of the developed algorithms in the scenarios prepared during the competition.

6.2 Project Limits and Constraints

Open source code and libraries can be used while developing algorithms. As the details will be stated in the technical specification, under different scenarios, different numbers of UAVs and UGVs can take place in the simulation environment as a swarm member.

7 SCORING

In the first stage, a "Preliminary Design Report" is requested to determine the teams that will participate in the competition. This report will be up to 15 pages. The preliminary design report will be detailed by the teams that have passed the competition and will be submitted to the competition jury as a "Project Report" consisting of a maximum of 60 pages. The project report and the preliminary design report will consist of the same sections as specified in Table-1, and the scoring criteria will be made by considering the same section and points as specified in Table-1. As a result of the Preliminary Design Report evaluation, the teams that get at least 70 points out of 100 will pass to the elimination phase formed by the evaluation of video and source codes. At this stage, it must be shown that the task requirements listed under the heading "5.2 Task Demonstration" in the video recording of at least 5 minutes or detailed analysis and simulation demonstration results are confirmed.

7.1 Scoring the Preliminary Design Report and Project Report

Preliminary design report and project report should be arranged in arial 10 format, single line spacing, at least 6 nk spacing between paragraphs. Reports will be prepared in Turkish or English. The reports will be uploaded to the contest web page in pdf format.

The reports will be evaluated over a total of 100 points and the scoring distribution is given in Table-1. The Project Report should contain at least the points in Table-1 for detailed design.

Table-1 Preliminary Design Report and Project Report Scoring

Section	Explanation	Preliminary Design Report Score	Project Report Score
Executive Summary	The summary of the project report should be expressed in a maximum of 300 words.	10	10
Project management	Project organization including team members should be given. Project calendar should be submitted.	5	5
Task requirements	Requirements should be established to cover all of the issues determined within the scope of the task in the competitor's specification.	25	10
Design solution	In this section, the competitor will detail the design alternatives and the most suitable design, current usage concepts, up-to-date algorithm and software designs. Relevant reference sources, if any, will be given in this section.	45	30
Demonstrating that key mission requests are confirmed	The competitor will explain in which aspect of the design the task requirements are realized in this section. In this section, the application-oriented details of the design solution, whose theoretical parts are explained, will be made.	0	30
Report format	Compliance with the report format, spelling and grammar rules, fluent and understandable language should be used.	15	15

Project Report scores will be announced at the information meeting on the day of the competition. 5 points will be deducted from the total score from the project reports over 60 pages.

Competitors will make a presentation on the first day of the competition. The presentation is evaluated over 30 points. On the day of the contest, 30% of the score obtained by the contestants from the Project Report and the presentation score will be added to the total score of the scenario and the total score will be calculated.

7.2 Scenario Scoring

Teams that pass the Evaluation of Video and Source Codes stage will be eligible to compete in scenarios. Scoring of the scenarios to be given will be made automatically by the simulation software. Scoring will be in the 3 categories given below. The scores obtained in the category will be added up and the final score will be calculated by deducting the penalty points, if any.

The modules that will make the scoring in the technical document and the whole simulation environment will be shared with the teams.

7.2.1 Optimum resource utilization and route planning

An optimization study will be carried out according to the total amount of vehicles required for the UAV and UGV swarm, the number of patients to be helped, and the distance to be traveled, and energy consumption will be taken into account.

7.2.2 Evacuation of Patients

With UGVs, it will be aimed to transport patients to the nearest available hospital.

7.2.3 Transport of Medical Supplies and Food to Patients

With UAVs and UGVs, it will be aimed to deliver health supplies and food to patients as soon as possible.

7.2.4 Constraints

- Fuel quantity must be observed and possible collisions must be prevented.
- More than one patient cannot be transported with the same vehicle.

8 SPECIAL RULES

8.1 Competition Registration of Teams

All teams must register in the competition hall until 10:30 on the first day of the competition.

8.2 Competition Information

On the first day of TEKNOFEST 2021, at 11:00, an informative presentation will be made in the competition hall and the issues regarding the competition will be notified to the teams. At least one person from each team must attend this meeting.

The competition order of the teams will be determined with the draw to be drawn during the information presentation. According to the determined order, the algorithms of the teams will be run in the scenarios prepared for the competition and the scenario scores will be calculated.

8.3 Ethical Rules

Teams that cheat, steal the opinions of others, etc. and exhibit unethical behavior at any stage of the Project Report and the competition will be disqualified from the competition.

8.4 Objections

Each team has the right to object in writing. Objections will be made in writing to the jury committee in the competition area. Unwritten objections will not be taken into consideration.

9 COMPETITION ORGANIZATION

The Swarm UAV Simulation Competition organization committee has the right to make any changes in this document until the competition.

9.1 Competition Committee

During the competition, there will be a sufficient number of people responsible for the organization of the project exhibition and project presentation activities.

10 AWARDS

After the competition, the competitors who are in the award ranking by meeting the success criteria specified in this specification will be awarded according to their rank as follows. The awards will be given to the teams, and no individual awards will be made.

Payment will be made to the advisor of the winning team within the scope of the competition. A payment of 2.000,00 ₺ will be made to the consultants of our ranked teams.

- First Prize: 40.000 ₺
- Second Prize: 30.000 ₺
- Third Prize: 20.000 ₺

Awards are valid for teams meeting the success criteria. An honorable mention award is given if the criteria for success are not met.

10.1 Minimum Success Criteria for Award Ranking

In order for the participants to receive awards, the swarm algorithms they designed must fulfill at least all of the following requirements in at least 3 different scenarios at least once.

- Patient evacuation
- Medical supplies transportation

In case the teams fail to meet the minimum requirements to enter the award ranking, honorable mentions may be given by the jury, and the relevant conditions will be determined by the jury and announced to the teams at the end of the competition.

11. GENERAL RULES

- Officials of each team have the right to appeal to the relevant referee. Objections can be made verbally, provided that they are submitted in writing later. Verbal objections are made in writing within 24 hours at the latest. In any case, unwritten objections will not be taken into consideration. The objections made are examined by the arbitral tribunal and resolved within 72 hours.
- After the announcement of evaluation results, only the authorized persons from each team may submit written objections and justifications. Objections are received from iletisim@teknofestistanbul.org.
- The appeal process must be made within one week - 7 days - after the results of the competition are announced. Otherwise, the objections are not taken into consideration.
- The duty of the consultant; to help students to plan their own education, to guide them in academic, social and cultural issues, to help prepare the appropriate environment for the development of the student's personality as a whole with its mental, social and emotional aspects, etc. tasks and services. The role of the consultant in the team is to provide the academic support that will be needed in the project, to guide the team members to find solutions to their problems.
- Each competitor is obliged to take the necessary safety precautions while racing and to show the expected attention to environment.
- Turkey Technology Team (T3) Foundation and the organizing committee, to take place in objective criteria of the competition terms can lead to fair results, contestants can be better met their every need, ensuring the safety measures and order becomes effective competition conditions reserves the right to make any changes in the present specification.
- T3 Foundation and the organizing committee reserve the right to cancel the contests in the event that there are not enough applicants who have the technical knowledge and skills required to participate in the contests as a result of the evaluations to be made after the application process.
- TEKNOFEST Safety and Security Specifications are notified to all competitors, delegations and relevant persons. All teams that will compete within the scope of the organization are obliged to meet the safety conditions specified in the TEKNOFEST Safety and Security Specification, specific to the competition they compete. In this respect, it is the competitors' responsibility to take additional precautions arising from the systems used, other than those included in the said safety instruction.
- T3 Foundation and the organization committee reserve the right to exclude teams that are found to not meet the conditions specified in the TEKNOFEST Safety and Security Specification in order to ensure that the organization can be held in a safe environment. The T3 Foundation and organization officials are not responsible for any damages that may occur as a result of the violations of the contestants, delegations and related persons during the competitions.
- Regarding the competition, the competitor accepts and undertakes all kinds of written or visual promotion, publication, social media and internet broadcasts to be made by the T3 Foundation and / or TEKNOFEST before or after the competition. Besides, including but not limited to; The contestant accepts and declares that any intellectual property produced in relation to the contest, including designs, codes and manufactured products, belongs to T3 Foundation and / or TEKNOFEST and that the competitor has no right or demand on it. The T3 Foundation reserves the right to publicly disclose all intellectual property as it deems appropriate.
- In the event that the T3 Foundation and TEKNOFEST suffer damage due to the violation of the intellectual and industrial property rights of any product, the said damages will be covered by the relevant team (including the consultant).
- All finalist teams that qualify to participate in the competition will be given a Participation Certificate.

Statement of Liability

- T3 Foundation and TEKNOFEST are not responsible for any product delivered by the competitors or any injury or damage caused by the competitor. T3 Foundation and organization officials are not responsible for damages caused by competitors to third parties. T3 Foundation and TEKNOFEST, the team is responsible for ensuring the preparation of their systems and practices in the framework of the laws of the Republic of Turkey.

Turkey Technology Team Foundation reserves the right to make any changes in the present specification.