31st Congress of the International Council of the Aeronautical Sciences
Belo Horizonte, Brazil; September 09-14, 2018

ALL JAPAN STUDENT'S INDOOR FLYING ROBOT CONTEST

Takeshi Tsuchiya*
***The University of Tokyo**

Keywords: *Aeronautical Education, Micro Aerial Vehicle, Society Activity, Competition*

Abstract

"All Japan Student's Indoor Flying Robot Contest" is held by The Japan Society for Aeronautical and Space Science annually. Micro aerial vehicles full of originality such as fixed-wing aircraft, airship, multicopter, and ornithopter, which are designed and manufactured by students of universities, colleges of technology, high schools and others, appear in the contest. We believe that this contest plays a role in educating aeronautical engineers in Japan. This presentation shows our activities of the contest.

1 Introduction

The Japan Society for Aeronautical and Space Sciences, JSASS holds "All Japan Student's Indoor Flying Robot Contest" from 2006. The 13th contest was held in September 2017, and the next 14th contest is scheduled in September 2018. Its purpose is to get students of universities, colleges of technology, high schools and others to acquire the aeronautical engineering knowledge, task discovery and its solution's ability, project management ability, and teamworking ability by designing, manufacturing and flying of flying robots. Also, diffusion and practical application of unmanned aerial vehicles, drones, and flying robots are objectives. We believe that the contest will develop human resources who will be responsible for aeronautical industry in the next generation.

2 Contest Overview

Each team composed of students is required to design, manufacture and fly manually or automatically controllable aircrafts flying in gym size space. Competitions are divided into four divisions: "General Division" in which the vehicles are only manually controlled, "Automatic Control Division" in which, adding to the manual control, automatic flight missions determined by rules are performed, "Multicopter Division" for multicopters, that is, drones which became recently popular, and "Unique Design Division" in which the participants have to present the characteristics of their unique airframes by themselves in the given time. Every contest had over 60 team entries from schools. After the registration of the entry, we set documentary examinations and video reviews, and then about 50 teams proceeded to the contest. In the contest, teams of vehicles making excellent flights in each division and vehicles specially selected by judges are awarded by sponsor companies.

In order to safely fly the vehicles inside the limited indoor space, regulations including weight, size, battery, and control method are decided. For example, the weight of the vehicles in "General Division" should be less than 200g, that of "Automatic Control Division" should be 250g or less, and that of "Multicopter Division" should be 300g or less. The participants make unique vehicles with originality such as fixed-wing type, airship type, multicopter type, ornithopter type and so on under the regulations. Basically, the fixed-wing aircrafts are made from lightweight materials such as balsa, carbon,

plastic film, paper, etc. Moreover, several equipment are installed in the airframes: propellers, electric motors, electric servo motors that drive control surfaces, batteries, radio controller, equipment to perform missions, and flight control board to perform the vehicles in "Automatic Control Division".

Let us explain what kind of flights are done in the contest performance with examples of the last year's contest. "General Division" and "Automatic Control Division" consist of a main mission and submissions. In the main mission, the team load the objects that is supposed to be aid supplies on the vehicle, take off it from the runway, and drop the objects in the specified areas. The accuracy of the position where the objects are dropped and the number of the objects, up to 3 objects, are scored. In the submissions of both divisions, whether or not to install additional weight, success or failure of a loop-the-loop flight, time trial flight between the specified positions, flight time of non-powered gliding, and success or failure of collecting the dropped objects are scored. Moreover, in "Automatic Control Division", the vehicle has to carry out some missions of automatic horizontal turn, automatic figure eight flight maneuver, automatic gliding, automatic objects dropping, and automatic takeoff and landing. The main mission, the submissions, and the total flight time are scored and the teams compete for the total scores.

In "Multicopter Division", the vehicle takes off from a designated port, shoots invisible instructions inside boxes with a camera installed on the vehicle, delivers an aid supply according to the instructions. In addition, there are submissions of tilting the vehicle to the left and right by an automatic control, that is, rocking wings and a figure eight flight maneuver by manual control or autopilot. These results and the total flight time are scored, and the teams compete for the total scores.

3 Background of the Contest

This section explains the circumstance that The Japan Society for Aeronautical and Space Sciences organized the flying robot contest for students.

As it is often pointed out in Japan, Japanese universities are hard to enter, but easy to graduate from. The contents of university educations, especially engineering educations had been criticized by the industry. It was said that the curriculums of the universities did not conform to the real society, and that there were large differences in the levels of the graduates. Therefore, in collaboration with academia and industry, The Japan Accreditation Board for Engineering Education, JABEE was founded in 1997, which certifies a professional education program to train engineers in higher education institutions such as universities on the basis of uniform standards. JABEE guarantees the quality of Japanese engineering education internationally and promotes training of internationally qualified engineers. A feature of the engineering education required by JABEE is practices of design educations, through which students can learn methods of problem solving. Although aerospace engineering educations emphasize design of aircrafts and spacecrafts, it is not easy to design, manufacture, and test real vehicles. They are limited to examining the concept.

Meanwhile, research and development of small unmanned aerial vehicles has been popular in universities, companies and research institutes since about 2000. It is because the performances and accuracies of electronic devices became higher and higher energy density secondary batteries appeared. Brushless DC motors, which have higher performance than conventional electric motors, were also available at low cost. As a result, radio-controlled airplanes propelled by gas engines have been electrified, and we can now easily build and fly small high-performance electric airplanes. We have studied the small unmanned aerial vehicles, calling them "flying robots".

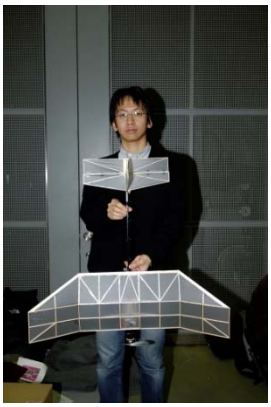
We noticed that electric powered flying robots can give students studying aeronautical engineering experiences to design, produce and fly aircrafts. For the practical educational activities of aeronautical engineering, university faculty members made a move towards holding a flying robot contest for students through The Japan Society for Aeronautical and Space

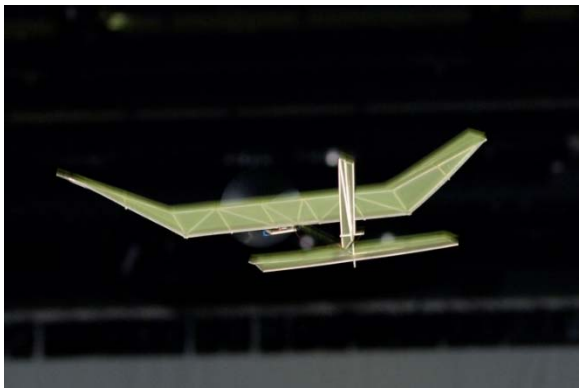
Sciences, and then held the first contest in January 2006.

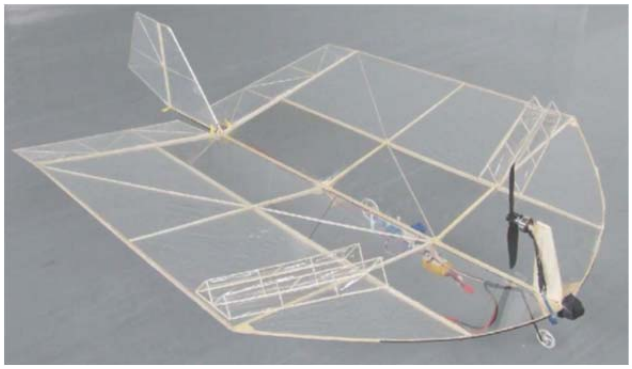
4 Flying Robots in the Contest

In the early contests, most of the fixed wing type vehicles resembled general aircrafts, and other anomalous forms could not fly well. However, according to the regulation and rule of the contest, the vehicles with adaptability to flight in the low Reynolds number has gradually increased. In addition, "Multicopter Division", which was established four years ago, has brought new schools and students that have nothing to do with aeronautical engineering to the contests, and driven awareness of flying robots.

The number of students who are active to participate in the contest is increasing, and the number of companies that approve the purpose of the contest is also increasing. The contest continues to expand. Thereafter, some pictures are shown.







5 Summary

The Japan Society for Aeronautical and Space Sciences has held "All Japan Student's Indoor Flying Robot Contest" 13 times. There are few examples of flying robot contests for students with educational aims. We define the regulations and rules and manage the contest through years of trial and error. The contest is supported by many volunteers who sympathize with the purpose of the contest. We would like to continue to provide a place of learning for students who are motivated to learn about manufacturing and aeronautical engineering.

References

[1] http://indoor-flight.com/
[2] https://youtu.be/8SU0HLyw1uk
[3] https://youtu.be/V955-9sE128

Fig. 1. Flying robots with originality designed by students.

6 Contact Author Email Address

mailto: tsuchiya@mail.ecc.u-tokyo.ac.jp

Copyright Statement