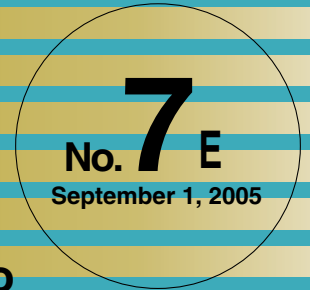




Newsletter

The 21st Century COE Program
Mechanical Systems Innovation, The University of Tokyo

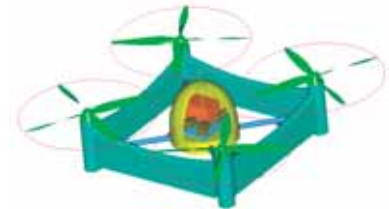
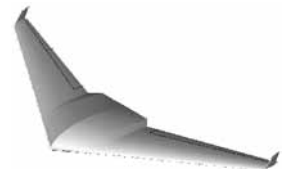


Innovative Aerial Robot Project (IARP)

In the 20th century, the main role of airplanes was to function as a means of transportation. Now, in the 21st century, it is expected that in addition to being a means of transportation, they will also play increasing roles in telecommunications, environmental/farmland/factory monitoring, accident prevention and disaster relief.

In order to meet those expectations, we are working toward the realization of innovative aerial robots, such as UAVs (Unmanned Aerial Vehicle) and MAVs (Micro Aerial Vehicle), which have multiple functions and advanced flight performance so that they can fulfill their various missions with success. Since 2004, this work has gone forward under the auspices of the Innovative Aerial Robot Project (IARP). In this project, cross-disciplinary members are cooperating closely under proper management by program promoters of the 21st century COE program.

To design and build innovative aerial robots, it is necessary to integrate elemental technologies from the field of mechanical engineering, such as fluid dynamics, structural mechanics, measurement, control and so on, as well as to develop each elemental technology. For example, the limits of application in conventional mechanical engineering arise when one attempts to miniaturize an aerial robot to the size of a hummingbird or insect. Each IARP team member addresses his or her own challenges in close cooperation with other members. Our goal is to contribute to the construction of a secure and safe society by giving robots new functions and widening their applicability. Additionally, we attempt to return our achievements to society in diverse ways.



Unmanned Aerial Vehicle (UAV)

Department of Aeronautics and Astronautics Prof. **Shinji Suzuki**

The Innovative Aerial Robot Project (IARP) team, with its winged innovative flying prototype robot, has succeeded in transmitting pictures from a camera onboard an aircraft and controlling the aircraft autonomously through cellular telephone communication system (2005/May/12 and 2005/May/17). The flying robot of the IARP team is the world's first small-sized Unmanned Aerial Vehicle (UAV) to use cellular telephones for the telecommunication of navigation and picture data.

Flying robots are expected to be of considerable use in missions such as early reconnaissance of disaster area and environment monitoring. The prototype robot that successfully flew the experimental flight (OBK-SkyEye2) was equipped with a camera, a GPS-enabled autonomous flight system, and two slot-in type cellular telephone cards. The aircraft (1.4 meters in wingspan and 1 kilogram in weight) is easy to control and can be hand-launched, which makes the system particularly suitable for emergency situations. The development of the robot has been sponsored by the New Energy and Industrial Technology Development Organization (NEDO) for the fiscal years of 2004 and 2005. It has been a cooperative effort between the university and other organizations. The robot was demonstrated at an emergency drill in Nagata Ward, Kobe City, and was on display at Expo 2005 Aichi Japan. More recent achievements include a successful proof-of-concept experiment to demonstrate the feasibility to conduct in-flight environment monitoring using the infrared photography technology developed at Hiroshima Prefecture Forestry Research Center. The IARP team is also conducting research on Micro Air Vehicles (MAV), wireless power transmission technology using microwaves, and composite materials for UAV applications.



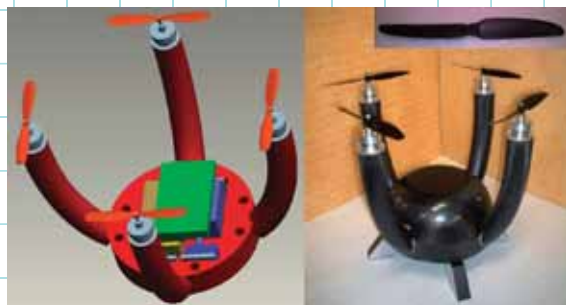
Television news coverage by NHK on 2005/01/31

Rotorcraft-type Micro Aerial Vehicle (MAV)

Department of Environmental & Ocean Engineering Lecturer **Hideaki Murayama**

In various situations, we can imagine applications for a small robot that can fly freely and safely in 3-dimensional space.

We are aiming to realize a rotorcraft-type micro aerial vehicle with multiple functions, namely, the ability to perform different types of motion, such as flying, running, hopping and so on. This robot has four rotors, and it can fly freely by controlling the rotation rate of each rotor. The main location where the micro aerial robot will be used is indoors. This means that the major challenges in developing the micro aerial robot are miniaturization and stabilization. Therefore, in order for a robot with small rotors to be able to fly freely, it is necessary that we make the fuselage lighter and develop an advanced control system. We could make an ultra-light fuselage using carbon-fiber-reinforced plastics (CFRP) and some microelectronic devices. Also, we have improved the thrust system and the control system. Our current goal is to develop a micro aerial robot whose maximum length is less than 30 cm and which is capable of stable hovering and has maneuverability.



Ultra-light MAV made of CFRP



Rover-type platform and MAVs

High-Performance Robot Exhibited at the 2005 World Exposition, Aichi, Japan

Department of Aeronautics and Astronautics Prof. **Shinji Suzuki**

Under a contract with NEDO (the New Energy and Industrial Technology Development Organization), the IARP team, Ohta Business Development Consortium (OBK), Mitsubishi Electric Corporation, and Chuo University collaborated on the development of a type of high-performance flying robot named the OBK-SkyEye. From June 9 to June 19, the robots were on display at the Prototype Robot Exhibition held in the Morizo & Kiccoro Exhibition Center of Expo 2005 Aichi Japan. OBK-SkyEye is a series of small flying robots equipped with cellular telephone communication systems and GPS-enabled autonomous flight systems (refer to the page on UAV for details). The all wing configuration model (Type 1) and the twin boom configuration model (Type 3) were on display along with a demonstration of how it is controlled using a flight simulator. Unexpectedly, there were very few hands-on displays at the exhibition, and our arrangement, in which visitors had the chance to fly the robot above the exposition site on a computer monitor, was quite popular among children. After the exhibition, one of the flying robots has been on display at the Communication Center located next to "Akamon" on the University of Tokyo's campus.



The high-performance flying robot and the flight simulator on display at Expo 2005 Aichi, Japan

Activity in IARP

Department of Environmental & Ocean Engineering Lecturer **Hideaki Murayama**

In IARP, we have performed various activities to promote close collaboration and improve the performance of team members. Cross-disciplinary members from the university, public research organizations, industry and so on attend our monthly meetings. Research reports and the exchange of information at the meeting are important for the purpose of project coordination. The international symposium on UAV and MAV was held for the first time in Japan in Dec. 2004. We organized this successful symposium, and we are preparing the next international symposium scheduled for Dec. 2005. Additionally, we are planning to hold an aerial robot competition for university and high school students in 2006. In preparation for the competition, IARP team members and various experts self-produced model airplanes last year and held a flight performance competition. As a result of these activities, collaboration among young researchers is closer. It is also notable that many graduate and undergraduate students are voluntarily taking part in IARP. We expect research and human resource developments to occur as a result of these IARP activities.



IARP monthly meeting



Competition on the flight performance of self-produced model airplanes



A self-produced model airplane

Program Executive Organization

Project Promoters

Program leader

Nobuhide Kasagi Professor, Department of Mechanical Engineering, School of Engineering

Energy innovation

Masahiro Shoji Professor emeritus, Department of Mechanical Engineering, School of Engineering

Toshio Nagashima Professor, Department of Aeronautics and Astronautics, School of Engineering

Chisachi Kato Professor, Department of Mechanical and Biofunctional Systems, Institute of Industrial Science

Takayuki Terai Professor, Department of Nuclear Science and Management, School of Engineering

Kazuro Kageyama Professor, Department of Environmental and Ocean Engineering, School of Engineering

Nobuo Takeda Professor, Department of Advanced Energy, School of Frontier Sciences

Tamaki Ura Professor, Department of Mechanical and Biofunctional Systems, Institute of Industrial Science

Shinichi Nakasuka Professor, Department of Aeronautics and Astronautics, School of Engineering

Toyohisa Fujita Professor, Department of Geosystem Engineering, School of Engineering

Shigehiko Kaneko Professor, Department of Mechanical Engineering, School of Engineering

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Kensuke Tsuchiya Project research associate, International Research and Education center for Mechanical Systems Innovation, School of Engineering

Yosuke Hasegawa Project research associate, International Research and Education center for Mechanical Systems Innovation, School of Engineering

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Shinji Suzuki Professor, Department of Aeronautics and Astronautics, School of Engineering

Keiji Kawachi Professor, Department of Aeronautics and Astronautics, School of Engineering

Yutaka Toi Professor, Department of Mechanical and Biofunctional Systems, Institute of Industrial Sciences

Shigeo Maruyama Professor, Department of Mechanical Engineering, School of Engineering

Marie Oshima Professor, Department of Mechanical and Biofunctional Systems, Institute of Industrial Science

Toshinori Watanabe Associate Professor, Department of Aeronautics and Astronautics, School of Engineering

Advisory Committee

Advisory Committee

Koutaro Inoue Senior Fellow, Japan Science and Technology Agency
Noboru Kikuchi Professor, The University of Michigan

Biomedical innovation

Mamoru Mitsuishi Professor, Department of Engineering for Synthesis, School of Engineering

Masao Washizu Professor, Department of Mechanical Engineering, School of Engineering

Masayuki Nakao Professor, Department of Engineering Synthesis, School of Engineering

Teruo Fujii Associate Professor, Department of Mechanical and Biofunctional Systems, Institute of Industrial Science

Takashi Ushida Professor, Department of Mechanical Engineering, School of Engineering

Hyper modeling / simulation

Yoichiro Matsumoto Professor, Department of Mechanical Engineering, School of Engineering

Takafumi Fujita Professor, Department of Mechanical and Biofunctional Systems, Institute of Industrial Science

Hideaki Miyata Professor, Department of Environmental and Ocean Engineering, School of Engineering

Shinsuke Sakai Professor, Department of Mechanical Engineering, School of Engineering

Shinobu Yoshimura Professor, Department of Quantum Engineering and Systems Science, School of Engineering

Project secretaries

Yuji Suzuki Associate Professor, Department of Mechanical Engineering, School of Engineering

Naoki Shikazono Associate Professor, Department of Mechanical Engineering, School of Engineering

Shin'ichi Warisawa Associate Professor, Department of Engineering for Synthesis, School of Engineering

Shu Takagi Associate Professor, Department of Mechanical Engineering, School of Engineering

Katsuko Furukawa Lecturer, Department of Mechanical Engineering, School of Engineering

Hideaki Murayama Lecturer, Department of Environmental and Ocean Engineering, School of Engineering

Yoshitsugu Kimura Chair, President, Kagawa University
Tetsuya Tateishi Fellow, National Institute for Materials Science

Activities of Mechanical Systems Innovation Program (scheduled)

<Open Seminars>

©FYI2005-3rd Seminar

Date : June 23, 2005
Venue : Seminar Room No.2, Faculty of Engineering Bldg.2, Hongo Campus
Subject : Thermal Stress Reduction for a Czochralski Grown Single Crystal
Speaker : Prof. Huaxiong Huang (York University)

©FYI2005-4th Seminar

Date : July 8, 2005
Venue : Lecture Room No.28, Faculty of Engineering Bldg.2, Hongo Campus
Subject : Coherent Thermal Emission in Modified One-Dimensional Photonic Crystals
Speaker : Assoc. Prof. Zhuomin Zhang (George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology)

©FYI2005-5th Seminar

Date : September 7, 2005
Venue : Lecture Room No.226, Faculty of Engineering Bldg.8, Hongo Campus
Subject : High-resolution Biophotonic Imaging
Speaker : Prof. Lihong V. Wang (Biomedical Engineering & Electrical Engineering, Texas A&M University)

©FYI2005-6th Seminar

Date : July 12, 2005
Venue : Sanjo Conference Hall, Hongo Campus
Subject : U.S. Microgrid Research
Speaker : Dr. Chris Marnay (Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory)

©FYI2005-7th Seminar

Date : August 8, 2005
Venue : Lecture Room No.226, Faculty of Engineering Bldg.8, Hongo Campus
Subject : Multiscale Simulations Using Particles
Speaker : Prof. Petros Koumoutsakos (Institute of Computational Science, ETH Zurich)

©FYI2005-8th Seminar

Date : September 8, 2005
Venue : Lecture Room No.226, Faculty of Engineering Bldg.8, Hongo Campus
Subject : Bioinspired Flow Optimization: Theory and Practice
Speaker : Prof. Petros Koumoutsakos (Institute of Computational Science, ETH Zurich)

©FYI2005-9th Seminar

Date : August 18, 2005
Venue : Conference Room (An301), Institute of Industrial Science Bldg.An, Komaba Campus
Subject : Multiscale Simulations Using Particles
Speaker : Prof. Petros Koumoutsakos (Institute of Computational Science, ETH Zurich)

<Industry-Government-Academia Interaction Meeting for Human resource Development>

©FYI2005-3rd Meeting

Date : June 21, 2005
Venue : Lecture Room No.226, Faculty of Engineering Bldg.8, Hongo Campus
Subject : Vision of Engineer Development
Speaker : Dr. Hideo Ohashi (Chairman, Board of Directors of Kogakuin University)

<Advisory Committee>

©FYI2005-1st Meeting

Date : August 4, 2005
Venue : Lecture Room No.226, Faculty of Engineering Bldg.8, Hongo Campus

The 21st Century COE Program Mechanical Systems Innovation, Newsletter No.7E

September 1, 2005

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In the interests of environmental conservation, this newsletter was printed using soybean oil ink.

