Department of mechanical system engineering
National Institute of Technology, Okinawa College

Development of the underwater robot for environmental research and protection in the coastal sea area of Okinawa prefecture, Japan

Name	Fumiaki Takemura	E-mail	takemura@okinawa-ct.ac.jp
Status	Professor		
Affiliations	IEEE, The Robotics Society of Japan, The Japan Society of Mechanical Engineers, The Society of Instrument and Control Engineers		

Keywords	Underwater robotics, Field robotics
Technical Support Skills	· Robotics · Mechatronics · Control engineering

Research Contents

Development of the underwater robot for environmental research and protection

We have been developing the underwater robot for coral reefs research and protection in the coastal sea area of Okinawa, Japan.

1. Development of the underwater robot for crown-thorns starfish control

   Crown-of-thorns starfish die by injecting the acetic acid. We succeeded to inject the acetic acid into crown-of thorns starfish by Remotely Operated underwater Vehicle (ROV).

2. Image-based position measurement of underwater objects

   Visual recognition of distant underwater objects is possible in the water with high transparency, for example, in the coastal sea area of Okinawa, Japan. So, we have been researching the image-based position measurement system of underwater objects using a low-cost maritime mobile robot with a monocular camera.

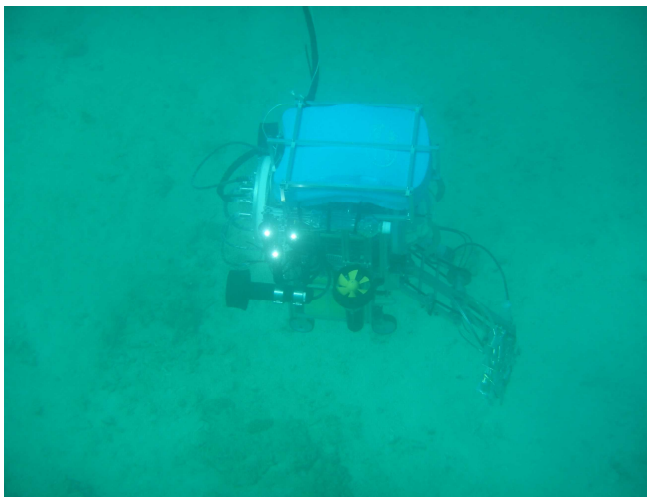


Fig. 1 Prototype of the developed underwater robot

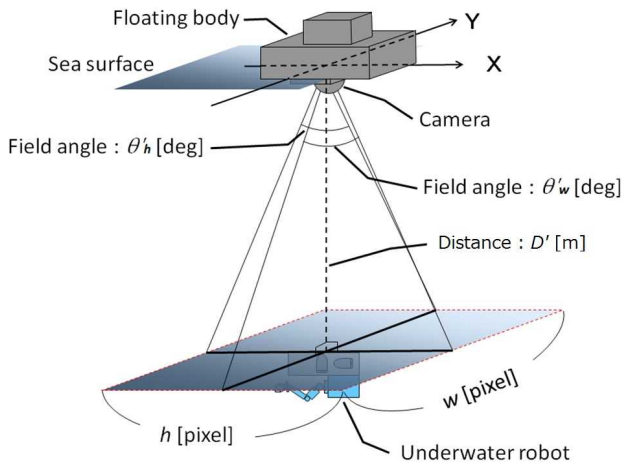


Fig. 2 Position measurement of an underwater object

Available Facilities and Equipment

Dept. Mechanical Systems Engineering,
Nat. Inst. Tech. (KOSEN), OKINAWA College

A Microscopic Internal Structure Analysis for Crystallographic Metals

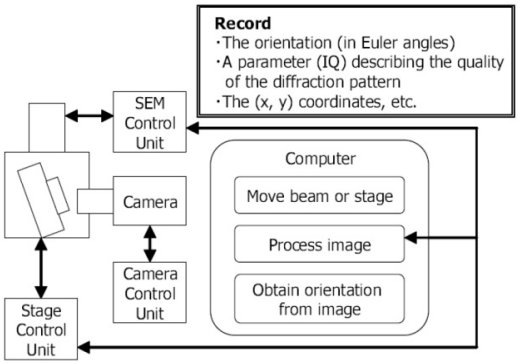
Name	HIGA, Yoshikazu	E-mail	y.higa@okinawa-ct.ac.jp
Status	Professor, Dr. Engng.		
Affiliations	The Japan Society of Mechanical Engineers (JSME) The Society of Materials Science, Japan (JSMS)		

Keywords	SEM/EBSD, AFM, Nano-Indentation, Visualization

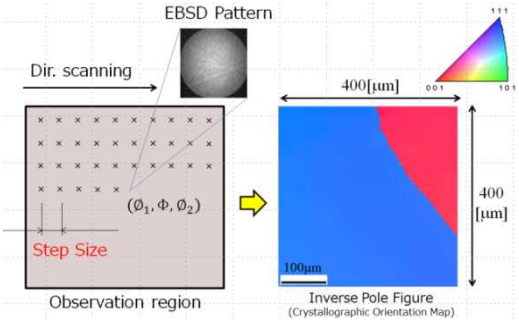
Technical Support Skills
・Crystallographic Orientation Mapping by SEM/EBSD Technique ・An Estimation of Material Characteristic using AFM & Nano-Indentation ・An Observation of Internal Structure and a 3D-Structural Analysis using μCT

Research Contents — Visualization of 3D Crystallographic Defects using SEM/EBSD technique

Crystallographic grains and defects play an important role in many fundamental processes, such as grain growth and recrystallization, damage, and plastic deformation. Due to the importance of these processes, there is considerable interest in characterizing the crystallographic orientation and grain boundary distribution of crystalline materials. In this study, an experimental investigation of the crystallographic defects, such as dislocation arrays, grain boundaries and its orientations, using electron backscatter diffraction (EBSD) mapping with a scanning electron microscope (SEM) have been performed in a commercial polycrystalline metals.

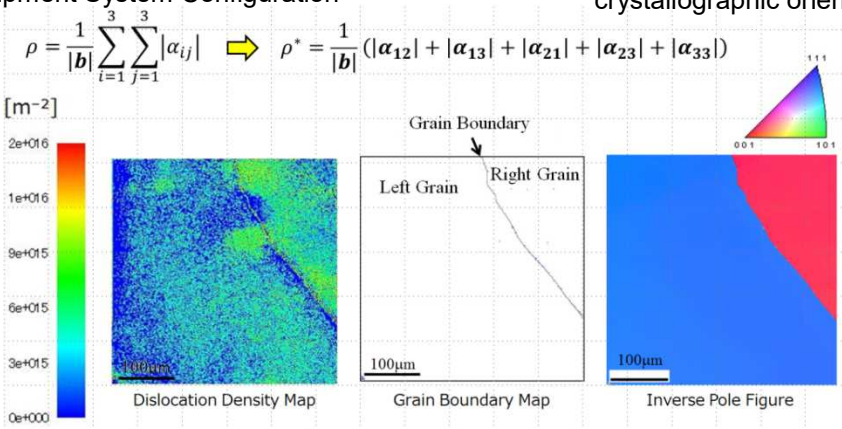


EBSD Equipment System Configuration



Local observation region and corresponding to crystallographic orientation map

$$\rho = \frac{1}{|\boldsymbol{b}|}\sum_{i=1}^{3}\sum_{j=1}^{3}|\alpha_{ij}| \quad \Rightarrow \quad \rho^{*} = \frac{1}{|\boldsymbol{b}|}\left(|\boldsymbol{\alpha}_{12}| + |\boldsymbol{\alpha}_{13}| + |\boldsymbol{\alpha}_{21}| + |\boldsymbol{\alpha}_{23}| + |\boldsymbol{\alpha}_{33}|\right)$$



Dislocation Density Map, Grain Boundary Map, Inverse Pole Figure

Yoshikazu HIGA, Ken SHIMOJIMA and Takashi MAKISHI, *Int. J. Multiphysics*, Vol.9, No.1 (2015), 37-43.

Available Facilities and Equipment

SEM/EBSD (TSL Solutions)	
Atomic Force Microscopy XE-100 (Park Sys.)	
Nano-Indentation (Hysitron)	

Department of Mechanical Systems Engineering
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Theoretical Study of Evaporation Heat Transfer in Horizontal Microfin Tubes

Name	Osamu Makishi	E-mail	omakis@okinawa-ct.ac.jp
Status	Professor		
Affiliations	The Japan Society of Mechanical Engineers(JSME), The Heat Transfer Society of Japan(HTSJ), Japan Society of Refrigerating and Air Conditioning Engineers(JSRaE)		
Keywords	phase change heat transfer, heat transfer enhancement		
Technical Support Skills	・design of the heat exchanger ・numerical analysis of heat transfer and fluid flow		

Research Contents

A stratified flow model and an annular flow model of evaporation heat transfer in horizontal microfin tubes have been proposed. In the stratified flow model, the contributions of thin film evaporation and nucleate boiling in the groove above a stratified liquid were predicted by a previously reported numerical analysis and a newly developed correlation, respectively. The contributions of nucleate boiling and forced convection in the stratified liquid region were predicted by the new correlation and the Carnavos equation, respectively. In the annular flow model, the contributions of nucleate boiling and forced convection were predicted by the new correlation and the Carnavos equation in which the equivalent Reynolds number was introduced, respectively. A flow pattern transition criterion proposed by Kattan et al. was incorporated to predict the circumferential average heat transfer coefficient in the intermediate region by use of the two models. The predictions of the heat transfer coefficient compared well with available experimental data for ten tubes and four refrigerants

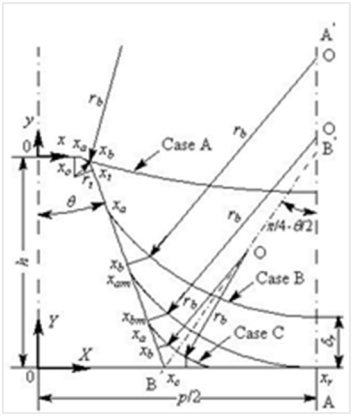

Fig.1 Physical model

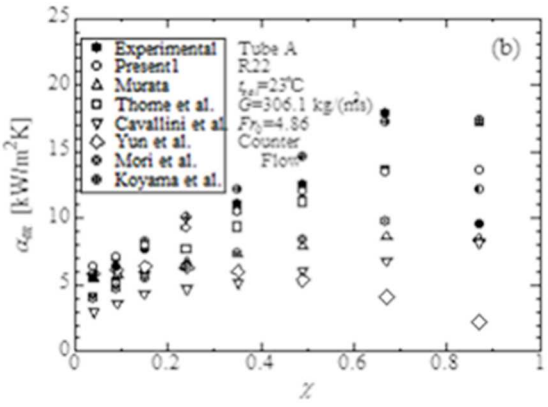

Fig.2 Comparison of measured and Predicted αvalue

Available Facilities and Equipment

Thermal Video System・TVS-8500(NIPON Avionics)	
Thermal Constants Analyser・TPS2500(Kyoto Electronics)	
Surface Tensionmeter・DY-700(Kyowa Interface Science)	

Department of Mechanical Systems Engineering
National Institute of Technology, Okinawa College

Studies of Surface Modification of Metals

Name	MAKISHI Takashi	E-mail	tmakishi@okinawa-ct.ac.jp
Status	Professor		
Affiliations	Japan Society of Mechanical Engineers		

Keywords	Surface midification、Heat treatment、Special needs education
Technical Support Skills	・Surface modification of Metals by using Plasma Nitriding ・Making and Improvement of teaching materials for special needs education

Research Contents

My research field is surface modification of metals by means of plasma nitriding process.
Characteristics of nitirided materials, fatigue properties are investigated in my studies.
Making and improvement of teaching materials for special needs education are also carried out in our laboratory.

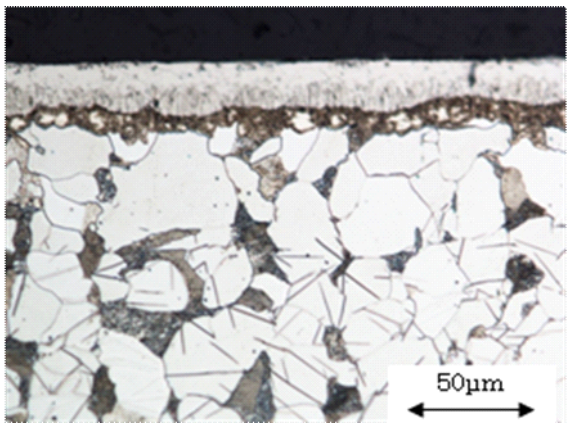

Fig. Typical microstructure of nitrided layer (low carbon steel at 610℃)

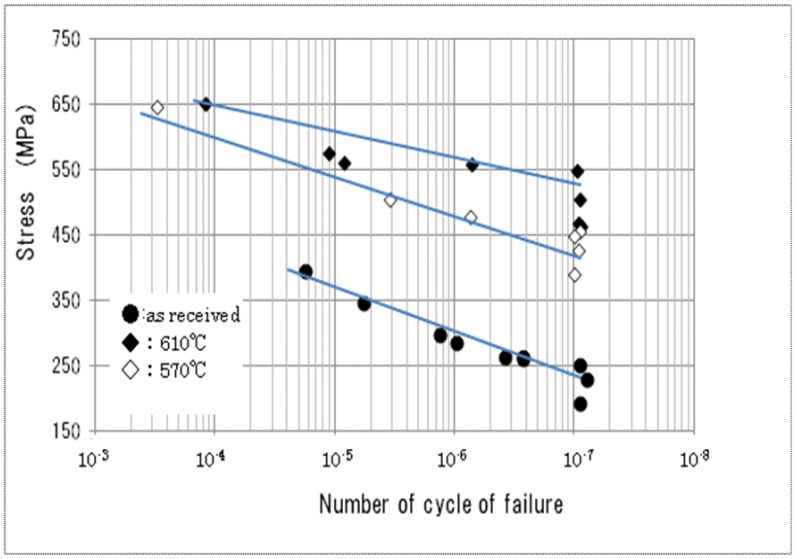

Fig. Example of S-N diagram before and after nitriding treatment, low carbon steel, niturising temperature at 570℃and 610℃.

Available Facilities and Equipment

Optical microscope	
Scanning electron microscope	
X-ray diffraction analysis	

Department of Mechanical Systems Engineering
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Advancement of mechanical system

Name	Ken Shimojima	E-mail	k_shimo@okinawa-ct.ac.jp
Status	Associate Professor		
Affiliations	JPFE		

Keywords	CMM, 5MC , Processing, Design(AutoCAD,SokidWorks)
Technical Support Skills	・Design and Manufacturing of machine mechanism ・Processing of metal material ・Measurement（CMM）

Research Contents

①Estimation of geometric deviation method by artifact at five axis control machining center

Estimation of geometrical deviation by measurement.

②Development of food processing machine by underwater shock wave

Food processing technology by underwater shock wave. It is possible on non-heating milling flour, sterilization, softening, and the extraction. Design and manufacturing of disintegrator and carrier machine to demanded food.

③Development of underwater fixed point camera with maintenance free

The camera is fixed at the bottom of the sea, and the ocean weather-ship observation of one month is possible.

④Study of cutting and junction property of composite materials (FRP)
Evaluation of various processing properties of composite materials

Available Facilities and Equipment

CMM-Mitsutoyo	
5MC-Mazak	

Welding & Joining, and Secondary Operation of Miscellaneous Materials by Heating

Name	TSUMURA Takuya	E-mail	tsumura@okinawa-ct.ac.jp
Status	Associate Professor		
Affiliations	Japan Welding Society, The Japan Welding Engineering Society, The Japan Institute of Light Metals, Japan Society of Mechanical Engineers, The Society of Materials Science, Japan		
Keywords	Solid-state Welding, Dissimilar Materials, FSW, FSSW, Arc, Laser, Surface Treatment		
Technical Support Skills	・Welding and Joining of Dissimilar Metals ・Metal-surface Treatment by Various Kind of Heat Sources		

Research Contents — Solid-state welding of dissimilar metals by using frictional heating

Solid-state welding of dissimilar metals by using frictional heating, like as Friction Stir Welding (FSW; as shown in Fig. 1), Friction Stir Spot Welding (FSSW; as shown in Fig. 2) are investigated in my studies.

Example of dissimilar metal joining:
・Pure copper to pure nickel by FSW (as shown in Fig. 3).
・Non-combustible magnesium alloy to galvanized steel sheets by FSSW (as shown in Fig. 4).

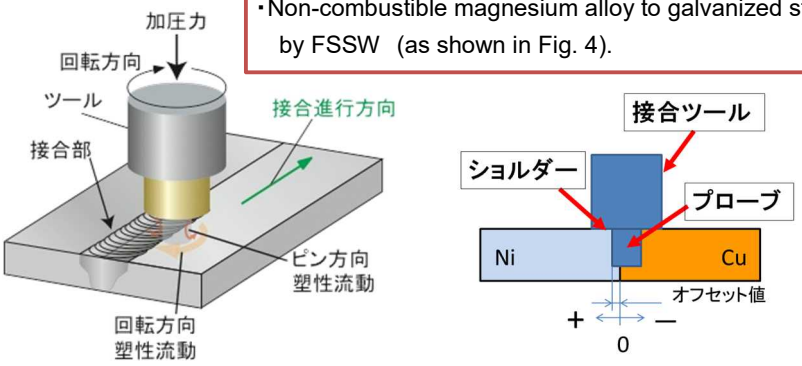

Fig. 1 Schematic illustration of FSW method and definition of offset value for offset-FSW.

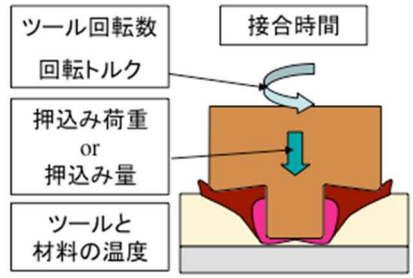

Fig. 2 Process parameters of FSSW method.

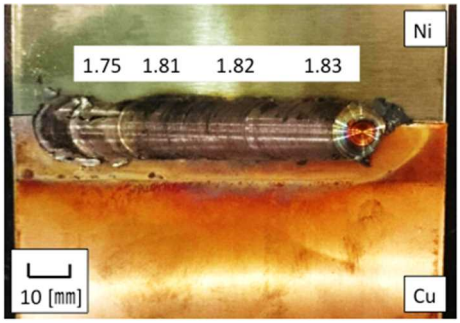

Fig.3 Appearance of pure copper to pure nickel butt joint by offset-FSW.

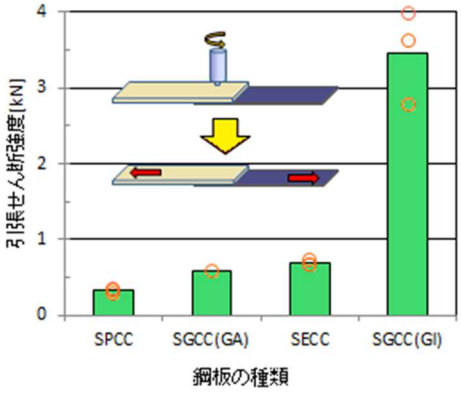

Fig. 4 Comparison of tensile shear strength of FSSW joints for non-combustible magnesium alloy and various galvanized steel sheets.

Available Facilities and Equipment

Arc and Laser welding apparatus	
Optical microscope	
Scanning electron microscope	
Energy dispersive elemental analyzer	

Department of Mechanical Systems Engineering
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Manufacturing Systems Analysis with Discrete Event Simulation

Name	Toba Hiroyasu	E-mail	toba@okinawa-ct.ac.jp
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Affiliations	IEEE, ACM, IPSJ (Information Processing Society of Japan), and JSME (Japan Society of Mechanical Engineers)		

Keywords	systems simulation, manufacturing systems, production schedule, SCM
Technical Support Skills	・performance evaluation of discrete systems with systems simulation ・analysis of discrete manufacturing systems ・production scheduling algorithms

Research Contents

The objectives of this research include undergraduate education and training in manufacturing systems engineering. Our research interest focuses on risk management in manufacturing systems through the use of virtual factories. We provide several research themes for undergraduate students who are interested in discrete mechanical systems such as robots or inspection instruments. We guide students to implement virtual factories by using commercially available discrete event systems simulators, and to develop several manufacturing systems based on their ideas or their inspirations and their experimental results.

Students of our undergraduate course finally learn to manage the risks by themselves in introducing their original manufacturing system developed in virtual factory, by thinking rationality from stand points of quality and reliability or maintainability.

Figure 1 shows process flows of two contest robot, these process flows are implemented into the virtual factory under several scenarios of manufacturing systems developed for two contest robots production. Figure 2 depicts probability distributions of lead time obtained from experimental results. The results show the effectiveness of their manufacturing systems developed for.

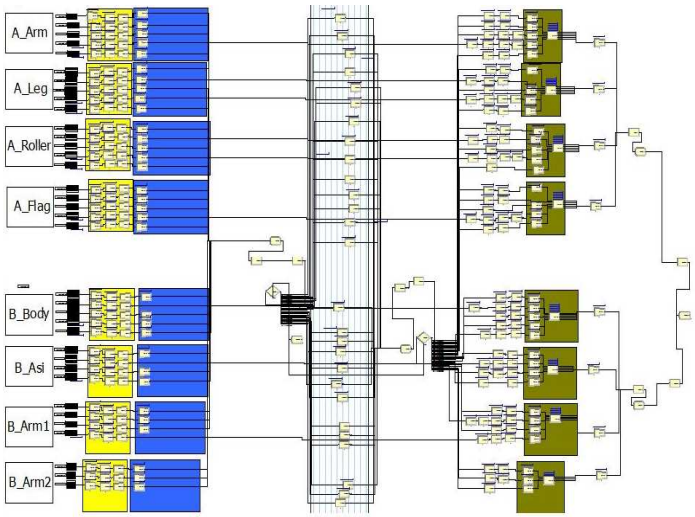

Figure 1. Process flows of Contest Robot Prototype

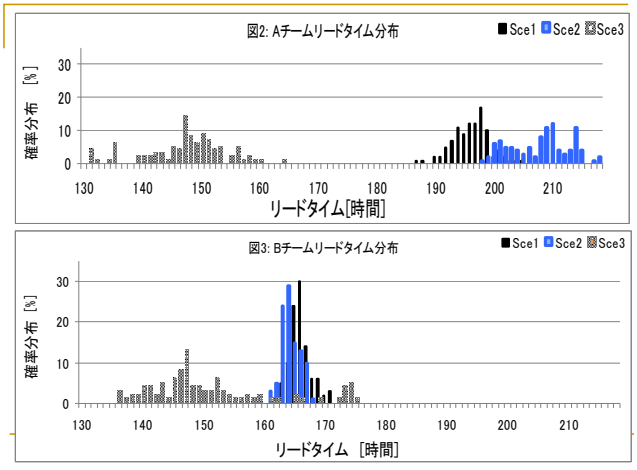

Figure 2. Two Prototype Lead Time Distributions

Available Facilities and Equipment

systems simulator Arena 14.7 (Rockwell Software)	
3D graphics simulator Auto Mod 12.3 (Applied Materials)	

Department of Mechanical Systems Engineering
National institute of Technology, Okinawa College

Evaluation of Fracture Mechanics of Material

Name	Kiyotaka MASAKI	E-mail	masaki-k@okinawa-ct.ac.jp
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Affiliations	The Japan Society of Mechanical Engineers The Society of Materials Science, Japan The Japan Institute of Light Metals		

Keywords	Material Strength, Fatigue , Surface modification, X-ray Computing Tomography
Technical Support Skills	・Investigation of fatigue property ・Evaluation of material strength ・Investigation of fracture mechanism

Research Contents

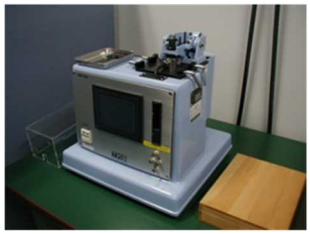
- Investigation of fatigue property
  - Conduct of the fatigue test
    - (Axial fatigue, Plane bending fatigue, Rotating bending fatigue, Torsion fatigue)
  - Obtain of the S-N diagram
- Evaluation of material strength
  - Obtain of the tensile strength, Hardness, Stress strain curve
  - Detection of internal defects of material with X-ray CT
- Investigation of fracture mechanism
  - Find out the cause of fracture by fractography with SEM

UH-F500kNI

PBF4-10

ORB-10

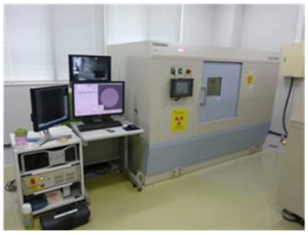
AG-IS 10kN



PBF-30X, 60X

EHF-EM 100kNI

CRB-MS-1



TOSCANER 32300uhd

Available Facilities and Equipment

Plane bending fatigue testing machine PBF-30X, 60X	Hydraulic servo fatigue testing machine EHF-EM 100kNI
Rotating bending fatigue testing machine ORB-10	High speed axial fatigue testing machine PBF4-10
Cantilever type fatigue testing machine CRB-MS-1	Industrial X-ray CT TOSCANER 32300uhd
Autograph AG-IS 10kN	Micro scope (SEM, OM, SM, etc.)
Universal testing machine UH-F500kNI	Hardness tester, X-ray diffraction analyzer etc.

National Institute of Technology, Okinawa College
Department of Mechanical Systems Engineering

Studies on design and development of control systems

Name	Kentaro Asato	E-mail	k_asato@okinawa-ct.ac.jp
Status	Lecturer		
Affiliations	IEEJ, ISCIE, SICE		

Keywords	Control engineering, Control theory, Soft computing
Technical Support Skills	· Design and development of control system based on control theory · Design and development of control system based on soft computing · Development of educational material for science and technology · Study on order reduction of controllers and models

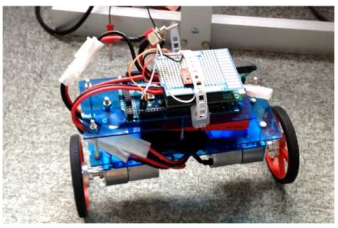
Research Contents — Design and development based on control theory and soft computing

(1) Development of nursing care devices

Because of declining birthrate and aging population, there is the critical labor shortage for nursing care in Japan. Furthermore, in order to prevent the long-term care, support apparatus for health maintenance is required. In this study, we are developing useful nursing care devices.

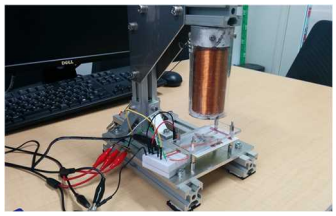
(2) Development of educational materials for learning science and technology

It is essential to acquire logical thinking based on mathematics in education of science and technology. In this study, we are developing a balancing robot, magnetic levitation system, and ball & beam apparatus as the educational materials, which are suitable to obtain the logical thinking.



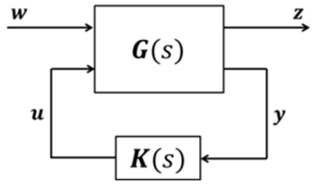
(3) Development of magnetic levitation system

Applications of magnetic levitation (maglev) control provide many benefits. However, construction of maglev systems require a high-cost in most cases. In this study, we are developing a Hall element displacement sensor with neural network in order to achieve lower-cost maglev system.



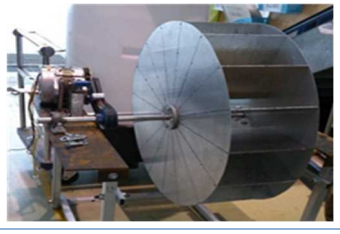
(4) System-order reduction

From the perspectives of system maintenance, implementation cost, and so on, it is a consequential problem to reduce the high order of system. In this study, we are trying to devise novel system-order reduction methods by using generalized Gramians and LMIs.



(5) Development of a Pumped-Storage Generation System using Batteryless Photovoltaics

In this study, we have been developing a micro-waterwheel generator. The micro-waterwheel generator is applied to the pumped-storage generation system using batteryless photovoltaics.



Available Facilities and Equipment

Programmable Logic Controller (Mitsubishi Electric)	Active suspension system (Quanser)
Matlab (Mathworks)	3DOF helicopter (Quanser)
Scilab (Scilab enterprises)	Magnetic levitation system (Original system)
Inverted pendulum (Servotechno)	Motor control experiment system (Original system)
Inverted pendulum with high fidelity linear cart (Quanser)	

Department of Mechanical Systems Engineering
National Institute of Technology, Okinawa College

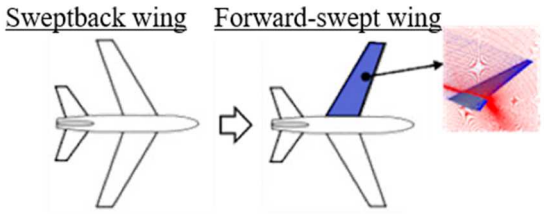
Research on Fluid dynamics and Aerodynamics

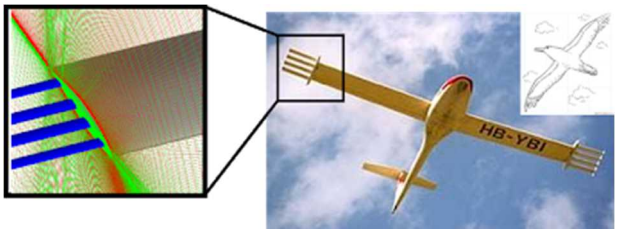
Name	Seiichiro MORIZAWA	E-mail	morizawa@okinawa-ct.ac.jp
Status	Lecturer		
Affiliations	The Japan Society for Aeronautical and Space Sciences (JSASS) The Japan Society of Mechanical Engineers (JSME) The Japan Society for Computational Engineering and Science (JSCEM)		
Keywords	computational fluid dynamics (CFD), data mining, multi-objective optimization		
Technical Support Skills	・Fluid analysis for transport equipment ・Information visualization		

Research Contents

① Aerodynamic design for future aircrafts

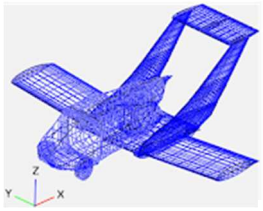
For the conceptual design of the future aircraft, the aerodynamic characteristics and flow fields of the forward-swept and bio-inspired wings have been investigated with the genetic algorithm and CFD. A new-type of wingtip devises are also discussed to reduce the induced drag of the aircraft as following figure.

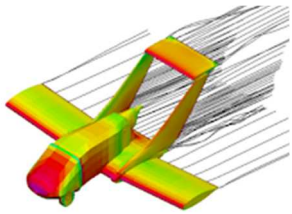




② Feasibility study on roadable aircraft

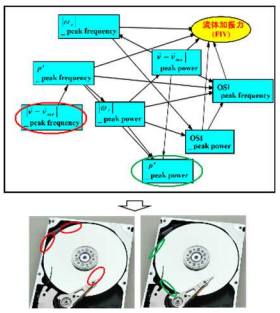
We have been investigated the feasibility of roadable aircraft between isolated islands using existing infrastructure such as local airports. The right figure shows an example of a roadable aircraft modeling “Pegasus” and computed by OpenVSP





③ Data exploration for huge volume data

To obtain universal information on huge volume data (ex. 4D data: time-series + space data), it is necessary to examine of various data and reveal these relations in a comprehensive manner. For this purpose, we have been suggested new methods to analyze them. The right figure shows a visualization example of the relations between temporal indices and flow induced vibration by Bayesian network.



Available Facilities and Equipment
