EM Scattering and Radiation by Rectangular Objects

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Job Title	Professor	Degree	Doctor of Engineering
Academic Society and Association	IEEE (Institute of Electrical and Electronics Engineers) IEICE (Institute of Electronics, Information and Communication Engineers)		
Research Keywords	Electromagnetic waves, Antennas, Computer Simulation		
Technical Fields and Topics possible for collaboration	▪ The exact formulation of the scattering, diffraction, and radiation from rectangular objects (including acoustic problems) ▪ The development of the software and providing high-precision numerical data		

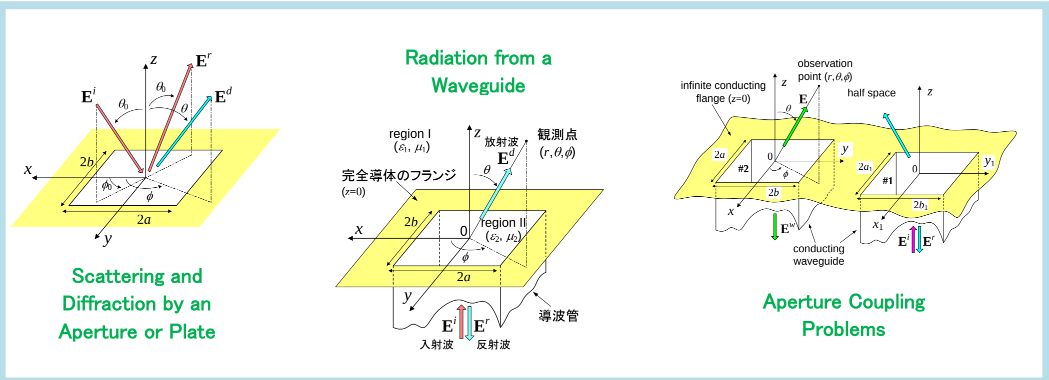
Details of the Research Theme

By using the derived exact solution of the canonical problem, it is possible to evaluate the accuracy of the conventional electromagnetic wave analysis software correctly.

In recent years, high-precision electromagnetic field analysis methods have been required for predicting electromagnetic phenomena and designing electromagnetic systems. In particular, it is known that a specific electromagnetic field component becomes very large near the edge of a scatterer with a metal edge, and this singularity depends on the edge shape and the ambient medium. In order to obtain accurate physical quantities, it is indispensable to incorporate the correct edge property (edge condition) in the field expressions.

The purpose of the research is to develop a rigorous analytical technique for analyzing electromagnetic scattering and radiation problems of perfectly conducting rectangular objects with edges, and to obtain exact expressions for physical quantities and highly accurate numerical data. By applying this solution, it is possible to evaluate the accuracy of conventional electromagnetic wave analysis software correctly, and to improve the reliability of computer-based product design.

[Examples of Canonical Problems]



Scattering and Diffraction by an Aperture or Plate

Radiation from a Waveguide

Aperture Coupling Problems

Formal Verification of Software System

Name	SUZUKI Yasuhito	E-mail	x-suzuki@numazu-ct.ac.jp
Job Title	Associate Professor	Degree	PhD (Information Science)
Academic Society and Association	Information Processing Society of Japan Japan Society for Software Science and Technology		
Research Keywords	Software Engineering, Formal Method, Real Time Logic		
Technical Fields and Topics possible for collaboration	・ Tutorial of software tools for formal verification of software ・ Development of the algorithm and tool for software verification		

Details of the Research Theme

Introduction education of formal method and implementation of verification algorithm to source code.

The vogue of deep learning caused forgetting some paper in recent years. It reports that Amazon uses the formal method when they develop the services. The company that is called GAFA, is developing its high quality services rapidly. The other countries are wondering why GAFA are able to do it, but the formal method is one answer.

I learn and study the formal method from a principle to implementation, and also have experience that teach tutorial education to students. These experiences provide formal verification curriculum to you company and develop verification algorithm for your source code.

Research on polarization imaging

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Job Title	Associate Professor	Degree	Doctor of Engineering
Academic Society and Association	JSAP, JSPE, OSJ, OSA, SPIE		
Research Keywords	Polarization imaging, Birefringence measurement, Mueller matrix polarimetry		
Technical Fields and Topics possible for collaboration	・ Polarization imaging technology ・ Birefringence measurement system technology ・ Mueller matrix polarimetry technology ・ Development of ellipsometry software		

Details of the Research Theme

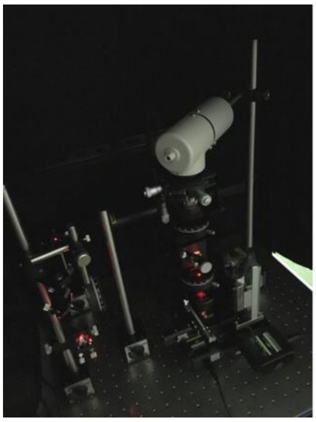
Development of a system for imaging polarization characteristics of optical materials and biological samples.

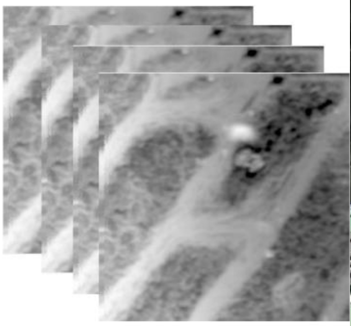
Sales point: Optical distribution that cannot be confirmed with the naked eye can be seen by using polarized light.

One of the characteristics of light is "polarized light". This is a phenomenon in which the vibration in the direction orthogonal to the traveling direction of light is biased. In nature, the rainbow is polarized, and chafer bugs with structural colors protect themselves from external enemies by polarization. Furthermore, polarized light is used in the liquid crystal displays that are close to us. Using this polarized light, various things can be measured. For example, plastic lenses generate residual stresses during the formation process, which results in partially ordered molecular arrangements at arbitrary positions, which in turn affects imaging. Therefore, using polarized light, it is possible to obtain irregularities in the molecular arrangement of such materials and elements by measuring them as physical quantities called "birefringence". In this laboratory, we are researching and developing devices that can quantitatively acquire quantities that cannot be confirmed by our naked eyes by using polarized light, and devices for imaging.

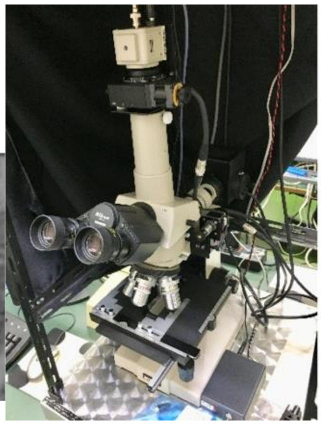
The main research themes are as follows.

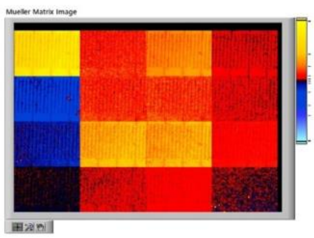
- Development of confocal laser scanning birefringence microscope
- Development of Mueller matrix polarization microscope
- Development of birefringence imaging system





Tomographic imaging of onion with confocal laser scanning birefringence microscope





Micrometer imaging with Mueller matrix polarization microscope

Development of Pediatric Artificial Heart System

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Job Title	Associate Professor	Degree	Ph. D
Academic Society and Association	Biophysical Society		
Research Keywords	Medical Equipment, Blood, Fluid Dynamics, Optical Eng.		
Technical Fields and Topics possible for collaboration	・ Development Process and Regulatory Application of Medical Equipment ・ Blood Compatible Materials and/or Surface Coating ・ in Vivo and/or in Vitro Compatibility Test Protocols and Procedures ・ Coagulation and Optical Properties of Pre-Coagulated Blood		

Details of the Research Theme

Save Pediatric Heart Failure Patients using Engineering Technology and Medical Research Ability

Our laboratory has studied pediatric heart failure and developed miniature blood pumps. Through this research, we are interested in blood coagulation and hemolysis of red cells. Especially for the use of small children, blood pumps easily destroy blood cells and coagulate plasma. These characteristics of pediatric blood make harder to develop pediatric artificial hearts.

To realize hemo-compatible blood pump, we have researched feature of pumps, bane shape of impeller, materials of pump, and surface coating. In addition, we've developed blood coagulation imaging system using birefringent of fibrine.

[References]

1. "High Resolution Ketone Measuring Method using Enzyme Reactions and Electrical Chemical Analysis", Biophysical Journal, Vol. 112, Issue 3, p456a-457a, February 03, 2017
2. "Fibrin Network Formation and Thrombolysis using a Birefringence Measuring" , Biophysical Journal, Vol. 112, Issue 3, p582a-583a, February 03, 2017
3. "Development of Aged Erythrocytes Separation Device using Lorentz Force", Biophysical Journal, Vol. 112, Issue 3, p280a, February 03, 2017

Theoretical study for relationship between cortical structure and functions

Name	MIYASHITA Masanobu	E-mail	miyasita@numazu-ct.ac.jp
Job Title	Professor	Degree	Ph. D
Academic Society and Association	Society for Neuroscience, International Brain science Organization, The Japan Neuroscience Society		
Research Keywords	Visual cortex, Auditory cortex, Self-organization, Cognitive neuroscience		
Technical Fields and Topics possible for collaboration	・ Brain-machine interface ・ Simulation method based on statistical physics ・ Pattern recognition technology		

Details of the Research Theme

The nervous system of our brain is superior to computer systems in features such as feature extraction of sensory information, decision making and memory retrieval. So far, we have reproduced the cortical structure of the visual / auditory area based on our self-organization model of the neural networks. We also study the relationship between the “structure” and “function” of the nervous system through research on cortical dynamics.

A Model Study of Neural Dynamics in the Auditory Cortex

Neurons in the mammalian primary auditory cortex (AI) have selectivity for frequency and sound intensities. In addition, the AI has a gradient representation of preferred frequencies, which is called a tonotopic map (Fig.1a tonopic map, Fig.1b sound intensity representation).

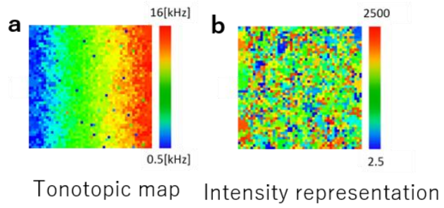
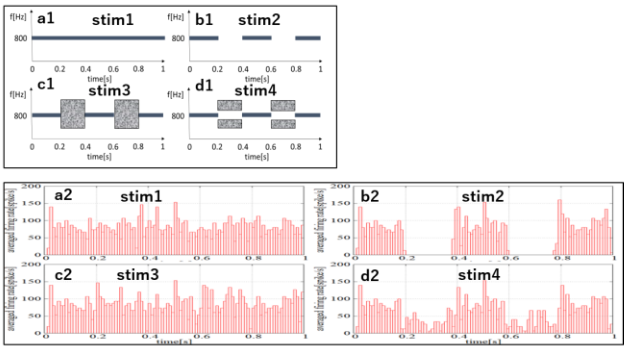


Figure 1

It is well known that when a continuous sound is partially replaced with periodic silent periods (gaps), we feel the sound to be fragmented (Fig.2a1 and b1). On the other hand, when the periodic silences are replaced with noise, we hear the continuous sound as a background of the periodic noise (Fig.2c1). However, little is known about what neural mechanisms cause this continuity illusion. To obtain a better understanding of this neural mechanisms theoretically, we carried out dynamical simulations of a large-scale network of spiking neurons that receive the self-organized afferent inputs from the medial geniculate nucleus (MGN) to the AI. As a result, it suggested that cortical lateral connections are involved in neuronal gain control, which may play an important role for the generation of auditory continuity illusion (Fig.2 a2-c2).



Sound signals
sim1: 800 Hz pure tone
sim2: sound of 800 Hz pure tone and gap switched every 200ms
sim3: sound with band noise inserted in the gap of sim2
sim4: sound with band noise (excluding 800 Hz) inserted in the gap of sim2

Figure 2 a1-d1: input signals, a2-d2: firing rate of model cortical cells

Smart Production Technology by Digital Engineering

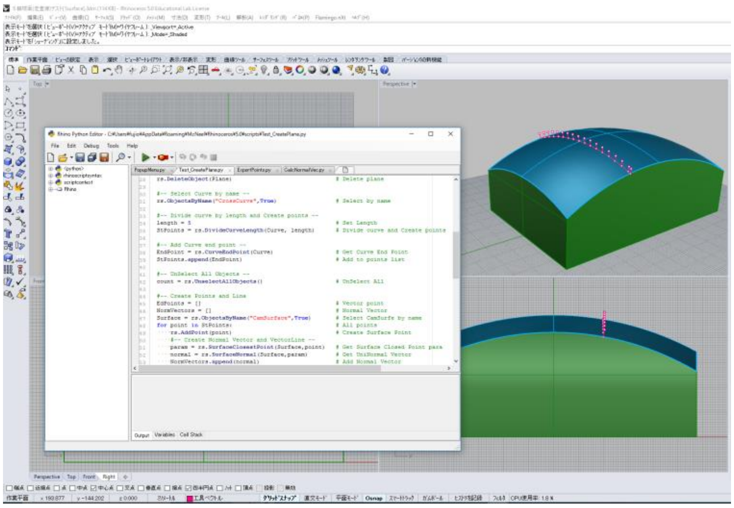
Name	FUJIO Mikio	E-mail	fujio@numazu-ct.ac.jp
Job Title	Professor	Degree	Doctor (Information Technology)
Academic Society and Association	The Japan Society for Precision Engineering		
Research Keywords	CAD/CAM, Polishing,, Customized software		
Technical Fields and Topics possible for collaboration	▪ Development of customization software for CAD software ▪ CAM development and evaluation experiments for deburring and polishing ▪ Prototype development and evaluation experiments using 3D CAD/Printer ▪ Development of NC machining simulation		

Details of the Research Theme

We are developing customized programs which can automatically design jigs and NC program on the CAD system such as SolidWorks, rhinoceros and so on. We are also developing a CAM for on-machine deburring and polishing using 5-axis machine tools.

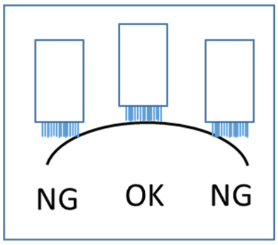
Dedicated jigs that are used for machining and measuring, are designed and produced at the production site. However, when performing a routine work using general CAD, it is required that skill and experience to design and machine the jigs. On the other hand, currently, commercial CAD has many commands called API to handle the CAD data and they are opened to the users. Users can customize CAD freely by using these API commands. In this laboratory, we customize commercial CAD suitable for users by using API commands to improve the work efficiency by interactive operation, short command and special parameter. We have developed customized software to use jig manufacturing and tool path generation applied to commercial CAD such as SolidWorks and Rhinoceros in the past. Moreover, we developed converter software for multiple CAD of 2D CAD using the DXF file format used in the woodworking industry. Currently, we are developing the on-machine multi-axis CAM system that can use for deburring and free surface polishing applying to ceramic brush, rubber bond grinding tool, and PCB tools. In particular, we are developing a system that can handle free-form surfaces using 5-axis control and multi-axis robot.

「Customized software on the Rhinoceros」

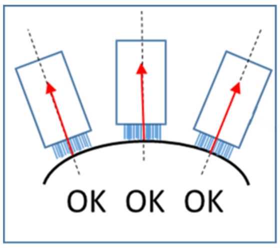


Developing screen(Python Script)

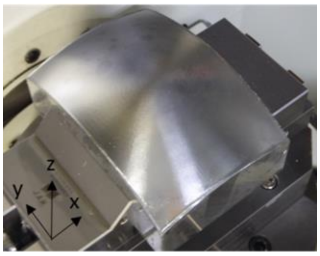
「On-machine polishing CAM」



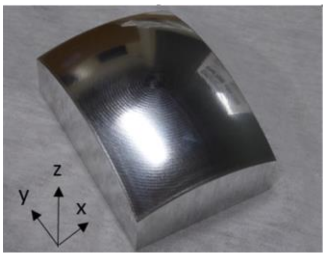
Three-axis control



Five-axis control



Before polishing



After polishing