

SUMMARY OF Ph.D. DISSERTATION

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Title Highly Functionalized Jet Array by Active Control of Fluid Motion		
Abstract A jet flow is widely used in industry such as heat exchanger, air conditioner, combustor and chemical reactor. For their high efficiency and capability, control of transport phenomena, e.g. profiles of temperature or concentration is required. Control theory is hardly applied to thermal fluid phenomena which respond to external environment in real time because fluid motion is strongly non-linear. Recent development of measurement system such as laser Doppler velocimetry and Particle Image Velocimetry and also computational fluid dynamics allows us to analyze fluid motion and control its profile. In the present study, a jet flow, which is widely used in industrial processes and one of the basic flow field, was focused. In order to highly functionalize jet characteristics such as mixing and heat transfer, an array of multiple jets was introduced. The objective si to establish a system of active control of fluid motion examining in experiments and numerical simulations. In chapter 1, the objective of thermo-fluid control system which introduced a scheme of feedback control was described with explanation of the back ground of this study and conventional flow control techniques. Chapter 2 explained fundamental aspects of the flow field generated by two or three jets array. By previous investigation of characteristics of heat transfer and flow structure formed by jet excitation in the past studies, appropriate conditions of the jets configuration for the controlled system. The principle of Particle Image Velocimetry and hot-wire anemometry were explained as fluid motion measuring system used in a real time control. Chapter 3 described control system to suppress fluctuation component as a disturbance in the time-averaged flow field of the two-dimensional parallel three jets. In air flow, by simultaneous velocity measurement three hot-wire anemometries. The location of the maximum velocity was evaluated in real time and controlled by changing the flow rate of each jet with inverter control of the blowers. In chapter 4, control of the heat transfer coefficient profile was performed. By excitation of jet flow through slits installed at the nozzle exits, stronger diffusion was achieved because of intensive vortex motion in the shear layer. Utilizing this characteristic, the state of impingement upon the wall was varied so that the heat transfer control was achieved. By addition of learning ability of neural network using the data of simultaneous measurement of two-dimensional velocity field by Particle Image Velocimetry and the wall temperature profile. It was confirmed that the desired wall temperature can be achieved. In chapter 5, the flow field dealt with in chapter 4 was calculated in numerical simulation. In order to realize large eddy structures in time series as teaching signals for offline learning of the neural network controller, Large Eddy Simulation (LES) was used. The numerical result of the heat transfer coefficient was agreed well with the experimental data. Chapter 6 summerized the results of the above studies and described possibility of controlling temporal and spatial profile of thermo-fluid in terms of controllable range of the system developed by this study.		