Study on OFDM Based Transmission Techniques for Next Generation Wireless LAN Communication Systems

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1. Introduction

The Orthogonal Frequency Division Multiplexing (OFDM) technique has been widely accepted and becomes one part of Wireless LAN (WLAN) industry standards for its efficient usage of frequency bandwidth and robustness to frequency selective fading. Recently, the researches on extending OFDM concept to the adaptive modulation method, multiple antenna system, and multiple access scheme have received considerable attentions for its potential to achieve the higher transmission date rate for next generation WLAN system. This research focuses on studies of problems in these OFDM based systems and proposes several novel methods to solve the problems so as to provide the promising solutions for practical considerations.

2. Proposed Methods

The OFDM technique in conjunction with adaptive modulation (AM) method is well known to enable significant improvement on transmission date rate of WLAN system. In practical system, the receiver needs to have the knowledge of the adaptive modulation information (AMI), which describes that which kind of modulation scheme is employed on each sub-carrier, and whose amount is usually proportional to the number of sub-carriers, and modulation schemes. Therefore, the large number of AMI bits would degrade the transmission efficiency and quality in practical AM aided OFDM system. This thesis proposes Grouping Adaptive Modulation (GAM) -OFDM method to reduce the number of AMI bits for AM aided OFDM system. The proposed GAM-OFDM method divides all sub-carriers into certain number of groups to reduce the AMI bits significantly at a cost of slight decrease of channel capacity. The proposal of GAM-OFDM system also includes an efficient transmission method of the AMI bits by using only two preamble symbols that are conventionally used for the frame synchronization and channel estimation. The proposed method employs the Multi-Carrier Spectrum Spreading (MC-SS) technique for the transmission of AMI bits to achieve the higher transmission quality even under severe multi-path fading environments.

The SDM (Space Division Multiplexing) -OFDM method is one of the promising solutions to extend Multi Input Multi Output (MIMO) technique to broadband communication system so as to achieve the linearly increased transmission date rate with increased antennas. For SDM-OFDM system, the number of AMI bit is also proportional to the number of transmit antennas. To solve the AMI problem in SDM-OFDM system, this thesis proposes AM aided SDM-SCOFDM (Single Carrier OFDM) method, which employs SCOFDM technique instead of OFDM technique so as to reduce the AMI bits remarkably. The proposed SDM-SCOFDM also has the advantage of low peak to average power ratio (PAPR), which would not cause severe performance degradation through nonlinear amplifier as conventional OFDM does.

The maximum likelihood detection (MLD) method is the optimal detection method for SDM-OFDM system in the term of minimum transmission error. However, the exhausted MLD search would become infeasible when the number of antennas and signal constellation size is large. Although several suboptimal detection methods exist, the performance is very far from the MLD performance. This thesis proposes the adaptive MLD (AMLD) and parallel MLD (PMLD) methods to achieve the near exact MLD performance with significant reduced computational complexity. The BER performance and complexity analysis show that the two proposed methods can outperform the conventional suboptimal methods and achieve very near optimal performance with low complexity.

In practical MIMO-OFDM systems, the efficient and highly accurate channel estimation method is the mandatory requirement to achieve the potential system performance. Although the conventional

DFT interpolation-based channel estimation (DFTI-CE) method could use the preamble symbols efficiently, it could no provide the high estimation accuracy of channel responses and suffers from the severe performance degradation when the zero padding is added at the transmitter to avoid the aliasing occurring at D/A converter. This thesis proposes the Discrete Cosine Transform interpolation-based channel estimation (DCTI-CE) method for MIMO-OFDM system to enable the estimation of all link conditions in high accuracy by using only one preamble symbol, even if the number of FFT points is larger than the number of subcarriers due to zero padding.

The Orthogonal Frequency Division Multiple Access (OFDMA) technique can be considered the extension of OFDM concept to multiple access scheme and expects to be able to improve the frequency bandwidth efficiency for the point-to-multipoint system by assigning different subchannel to individual users. However, since the subchannels for individual users will fluctuate over a wide range due to their different multi-path fading conditions, the overall system performance of the fixed subchannel allocation method will degrade severely. Furthermore, the conventional adaptive subchannel and bit allocation method could not satisfy the practical requirements due to the high computational complexity. This thesis proposes an efficient adaptive subchannel allocation (ASA) method for OFDMA system, which employs priority rule based allocation algorithm, and assigns subchannel to each according to its instantaneous channel conditions. Then, this thesis proposes adaptive subchannel and bit allocation (ASBA) method for OFDMA system by introducing the GAM concept to ASA-OFDMA system. The salient feature of the proposed method is to employ the low complexity allocation algorithm for assigning both of the subchannel and modulation scheme to each user adaptively so as to improve the channel capacity with keeping the required signal quality. This thesis also proposes the OFDMA system with time and frequency domain code division multiplexing (TFCDM) method to achieve both time and frequency domain diversity gains so as to improve the signal quality under severe multipath fading environments. The proposed OFDMA-TFCDM method assigns different spreading codes to each data signal of the same user in OFDMA system. This kind of processing will not cause any user interferences at the receiver so as to enable the simpler detector without the requirement of the complicated multiple user detection technique as well as achieving diversity gains.

3. Conclusions

The numerous computer simulations are conducted to confirm the effectiveness of all proposals included in this thesis. The measurements of transmission quality, channel capacity, complexity analysis, and estimation accuracy, etc, are employed to evaluate these proposed methods. As a conclusion of researches in this thesis, the OFDM based techniques could provide various practical solutions for next generation high date rate WLAN system.

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Study on Aerodynamic Force Acting on Rotating Blade in Field Horizontal Axis Wind Turbine

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Keywords: Fluid Machinery, Wind Mill, Blade, Pressure Distribution, Stall, Unsteady Flow, Yaw Effects, Shear Flow

1.Introduction

Though in recent years there has been substantial progress in the aerodynamic modeling and design of horizontal axis wind turbine, there is still a failure to predict high aerodynamic loads. Though today's rotor blade is taking out about 40% of wind energy, it is possible to take it out up to 59.3% theoretically. However, because the distribution of wind direction and speed changes, the amount of energy that can be actually taken out is influenced by wind condition.

Generally, wind turbine blade airfoil is designed by 2D numerical analysis combined with blade element momentum theory, and verified in the wind tunnel test. However, in the field, the flow around the wind turbine blade is unsteady, and it becomes complex due to the effect of Coriolis force, centrifugal force and three-dimensional flow. It is uncertain that sufficiently detailed field measurements exist for validating aerodynamic models against the actual three-dimensional, unsteady flow. Complexity of the flow behavior on the wind turbine blade, makes it necessary to provide more data and for a broad range of experimental conditions.

This thesis shows the wind profile of upstream, and the pressure distribution on a rotor blade of a 10m-diameter wind turbine. The upstream wind condition of wind turbine and the aerodynamic force characteristics of rotor blade are clarified by field experiment data, and it is used to develop the rotor blade and improve the wind turbine performance in the future.

2.Experiment and remarks

Results of this thesis are as follows:

(1) At the radial section which close to two dimensional flow condition, the aerodynamic force improves from the wind tunnel experiment.

(2) At the radial section in which the mainstream wind influence becomes remarkable, when the spatial in-homogeneity of the wind speed profile is large, the aerodynamic force decreases more than the wind tunnel experiment.

(3) At the radial section in which the mainstream wind influence becomes remarkable, the aerodynamic force decreases more than the wind tunnel experiment in yawed condition.

This result is not reflected in a current blade design, and it seems that it greatly influences development of a rotor blade and a three-dimensional blade shape in the future. In addition, it proposed a concrete method to keep the aerodynamic force of the rotor blade to be large from the correlation of an atmospheric turbulence and an aerodynamic force of rotor blade.

3.Conclusions

In the region of a large atmospheric turbulence and a complex terrain such as Japan, it is necessary to research including the upstream wind condition of wind turbine and the aerodynamic force characteristics of rotor blade. Therefore, the data of aerodynamic force characteristic of rotor blade in operating condition are

demanded to design a blade. It is believed that the result of this thesis contributes to development of rotor blade, which shows high efficiency in unsteady shear flow.

Table 1 Contents of thesis

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A Study on the Landscape Administrative Measures Centered on the Landscape Ordinance in the Prefectures

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Keyword: the Prefectures, landscape ordinance, landscape administrative measure

1. The Background and Purpose

In Japan, the equipment and preservation of the landscape has been wrestled mainly with the landscape ordinances of the Prefectures and the municipalities from 1960's. The number of the landscape ordinances is 27 in the Prefectures, in the case of including the municipalities about 500. In 2004, the Landscape Law's been enacted, for taking a new turn, it's important to estimate thus landscape administrative measures.

So in this study, I'll make clear the roles of the landscape administrative measures while taking the relation between the municipalities into consideration, and survey how the landscape administration of the Prefectures should be in future.

2. The types and change of the landscape ordinances in the Prefectures

About the present condition of the landscape administration of the Prefectures and the municipalities, we've made the hearing from 2002 to 2005.

It's clarified that in the main measures of the landscape ordinances of the Prefectures and the municipalities there're "the landscape-forming region etc. (the wide-landscape region and the landscape-forming district)", "the large-scale activities etc.", "the important landscape structure etc." and "the public enterprise etc." as the hard measures, "the enlightenment etc.", "the landscape-forming agreement", "the landscape-forming group" and "the support etc." as the soft measures.

According to these analyses, the landscape ordinances of the Prefectures' been classified in 3types of the region protective type which regulates a limited region and has begun in 1969 in Miyazaki, the total development type which has the hard and the soft measures for all region of the Prefectures and has been established in the 20 Prefectures from the beginning in 1984 in Shiga, and the idea active type which supports with the soft measures only the landscape formation by the lead of the residents and the municipalities and has established in 2000 in Fukuoka, in 2001 in Hokkaido.

Still more, through the analyses of the correlation of the landscape ordinances of the Prefectures and the municipalities, the landscape ordinances of the Prefectures have classified in 3 types of the standing side by side type for the Prefectures and the municipalities of the region protective type, the adjustment type for the Prefectures and the municipalities of the total development type, the self-support type for the Prefectures and the municipalities of the idea active type.

3. The applying circumstances of the adjustment type

The characteristic of the adjustment type is that the Prefectures can apply the landscape administrative measures suitably in by the shift etc. in response to the circumstances of the municipalities. The Prefectures entrust the municipalities with the landscape administrative measures fundamentally avoiding the duplication of the region by the shift in the case which the municipality enact the landscape ordinance having the hard measures afterward for planning the landscape formation in all region by the hard measures.

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Besides, a part of the Prefectures act the competence devolution and the consignment contract.

The soft measures don't be shifted basically and the Prefectures and the municipalities apply their administrative measures severally. But under some circumstances, the Prefectures put in joint support, promote the administrative measures for the support, and improve the consciousness of the municipalities.

4. The applying circumstances of the standing side by side type

The characteristic of the standing side by side type is that the Prefectures apply the hard and the soft measures for the wide landscape in spite of the circumstances of the municipalities. It has cased the doubleness of the notifying system for the duplication of the region in the Prefectures and the municipalities.

5. The applying circumstances of the self-support type

The characteristic of the self-support type is that the Prefectures can act the own administrative measures effectively for the municipalities which have the landscape ordinances regulating the administrative measures directly.

As the case of "the wide-landscape region" etc., it seems to be the subject that the Prefectures can't act the landscape formation by the administrative measures directly.

6. The roles of the landscape administrative measures

From these analyses, in the landscape ordinances of the Prefectures, it's clear that there're 3 roles which are the wide region role acting the landscape formation extending all over the plural municipalities, the leading role that the Prefectures lead the administrative measures of the municipalities and the promotive role promoting the landscape administrative measures of the municipalities etc. .

Though the standing side by side type has the wide region role and the self-support type has the promotive role, the adjustment type has all 3 roles. Thereupon the adjustment type is the most effective for the promotion of the landscape administrative measures smoothly.

Then I suggest about the adjustment type for the Prefectures and the municipalities to work together still more from 2 view points.

One is that in the landscape ordinances it needs to prescribe all of the main administrative measures concluding "the important landscape structure etc." and "the landscape–forming group" which haven't been acted enough.

The other is to carry favor with the competence devolution, the consignment contract, the unification of the notifying system, the joint support etc. for acting the promotion of the landscape administrative measures.

7. The future view

According to "the unification of the landscape administration" of the Landscape Law, in the case that both the Prefectures and the municipalities are the landscape administrative party, in principle the municipalities bear the landscape administration. So it's worried about that the Prefectures can't bear the wide region role, the promotive role and the leading role sufficiently and that it cases the region which the regulation doesn't reach. Therefore it's desirable that the Prefectures build the working relationship with the municipalities and make good the both landscape ordinances by the Landscape Law.

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A Study on Historic Conservation Plan by the Integration of the Fields of Cultural Property Preservation and Landscape Conservation by Local Authorities in Taiwan

– Focus on the Comparison with the System of Preservation Districts for Groups of Historic Buildings in Japan-

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Keywords: Taiwan, Historic Conservation Plan, Cultural Property Preservation, Landscape Conservation, System of Preservation Districts for Groups of Historic Buildings

1. Research Purpose

This purpose of this research is first to analyzes the transition and current status of the historic environmental conservation systems and conservation plans in Taiwan in modern times, focusing on the following two point of views: 1. the local government's role in decentralization society", and 2. conservation plans by integration of the fields of cultural property preservation and landscape conversation. Then, the second purpose is to analyze the characteristics and issues, and the possibility of the contribution to Taiwan by Japanese experience through the comparative analysis with the situation of Japan. Finally, based on the above analysis, give the proposal of the basic frame of the historic environmental preservation plan with integration of fields of cultural property preservation and landscape conversation by the local authorities in Taiwan on the study of "village conservation system" newly enacted in 2005.

2. Related to prior arts

This research which intergrades two fields, "cultural property preservation" and "landscape conversation", and lets a comparative analysis with Japanese experience. Therefore, the meaning of considering the characteristics on the preservation in Taiwan is significant.

3. Contents

This research consists of introduction chapter and other 6 chapters.

In introduction chapter, it discusses the background, the purpose and points of view, the framework of research, the research method, the analysis of previous research and the positioning of this research, and terminological definition.

In Chapter 1, it discusses the transition of the historic environmental conversation systems in Taiwan. by dividing into 5 periods, and mentions about the background and the main contents of establishment in each period from two flows, "transition of a cultural property preservation related systems", and "transition of landscape conversation related systems".

In Chapter 2, it discusses the current conservation systems("village conservation system" ,"conversation area System", "exclusive use district system", "special district system", and "national park system", by analyzing the frame of systems, authorities in charge, and the operation.

In Chapter 3, it analyzes 4 case studies(Lu-gang conversation Area in Zhang-hua prefecture, Da-Dao-Cheng exclusive use district in Taipei city, Er-kan special district in Peng-hu prefecture and Kinmen national park in Lian-jiang prefecture based on the preservation situation of above systems, by analyzing the background, the plans.

In Chapter 4, it discusses the transition of the historic environmental conversation systems in Japan. by dividing into 6 periods, and mentions about the background and the main contents of establishment in each period from two flows, "transition of a cultural property preservation related systems", and "transition of landscape conversation related systems".

In Chapter 5, Focusing on the the conversation regulations and plans of 64 national designated districts based on System of Preservation Districts for Groups of Historic Buildings in Japan , by analyzing the authorities in charge, preservation regulations, the contents of the preservation plan, and the preservation situation.

In Chapter 6, it analyzes the characteristics and issues, and the possibility of the contribution to Taiwan by Japanese experience through the comparative analysis with the situation of Japan. Finally, based on the above analysis, give the proposal of the basic frame of the historic environmental preservation plan with integration of fields of cultural property preservation and landscape conversation by the local authorities in Taiwan on the study of "village conservation system".

4. Concluding Remarks

1) The Characteristics and issues of the current conservation systems in Taiwan are as follows:

The Characteristics of the current systems is the establishment of Village conversation system, and the issues are lack of clear definition for conversation district, lack of integration of cultural property preservation system and landscape conversation system, inadequate technical standard on the plan making, etc.

2) The Characteristics and issues of the current conservation plans in Taiwan are as follows:

The Characteristics of the current systems is the establishment of Village conversation system, and the issues are lack of clear definition for conversation district, lack of integration of cultural property preservation system and landscape conversation system, inadequate technical standard on the plan making, etc.

3) The proposal of the basic frame of the historic environmental preservation plan on the study of "village conservation system" are as follows:

① The clarification on the definition and establishment of "village conservation district".

② The clarification of technical standard on the plan making.

③ Integration of cultural property preservation system and landscape conversation system by local authorities.

④ Conversation of historic villages and the surroundings by local authorities.

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Study on Motion Control of Flexible Arm Considering Sensor Failure

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Keywords: Fault-tolerance, Sensor Fault, Flexible Arm, Reaction Force Estimation

1.Introduction

In recent years, control system reliability has received much attention. In order to improve reliability, control systems need to have abilities to detect a fault (fault detection) and to maintain the stability and the control performance (fault tolerance). This paper is concerned with the vibration suppression control of a one-link flexible arm robot. In our control system, vibration suppression is realized by an additional feedback of a strain gauge sensor attached to the arm besides motor angle. However, a sensor fault may degrade a control performance and make the control system unstable at its worst. In this paper, we propose a fault-tolerant control system for a disconnection fault of a strain gauge sensor, and the effectiveness of the proposed fault-tolerant control system is examined through experiments.

2.Proposed control system

In the case of a strain gauge sensor fault, it is possible to maintain a stability of the control system by interruption of a faulty sensor signal. However, this interruption results in poor vibration suppression. In the control system of the flexible arm, it is desirable to maintain not only a stability of the control system but also a vibration suppression performance after a strain gauge sensor fault. For this purpose, we propose a new fault-tolerant control system to

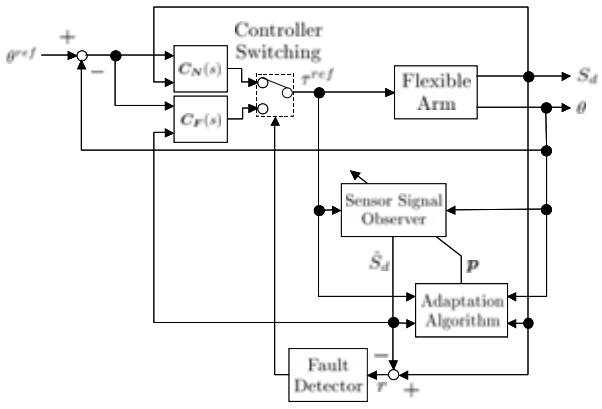

Fig.1 Proposed control system

- estimate a strain gauge sensor signal,
- detect a fault by monitoring an estimation error between the sensor signal and the estimated value
- exchange a faulty sensor signal for the estimated one, and

- maintain a stability and a control performance after switching from a faulty sensor signal to the estimated one.

Figure 1 illustrates a configuration of the proposed fault-tolerant control system. The proposed system is constructed by adding a strain gauge sensor signal observer, an adaptive algorithm, a fault-mode controller $\boldsymbol{C_F}$, and a fault detector to the (normal) control system of the flexible arm.

3.Experimental results

In order to verify the effectiveness of the proposed fault-tolerant control system, a disconnection fault of the strain gauge sensor occurs virtually at 180.35[s]. Figures 2 and 3 show the motor angle θ and the distortion of the arm S_d, respectively, together with the no-switching case for comparison. The no-switching case means that only interruption of a faulty sensor signal is performed. The tracking performance associated with the motor angle θ has little degradation. While the vibration suppression performance much degrades in the no-switching case, the proposed case shows enough vibration suppression close to the fault-free scenario. These results show that the proposed fault-tolerant control system maintains the stability and the overall performance after the strain gauge sensor fault.

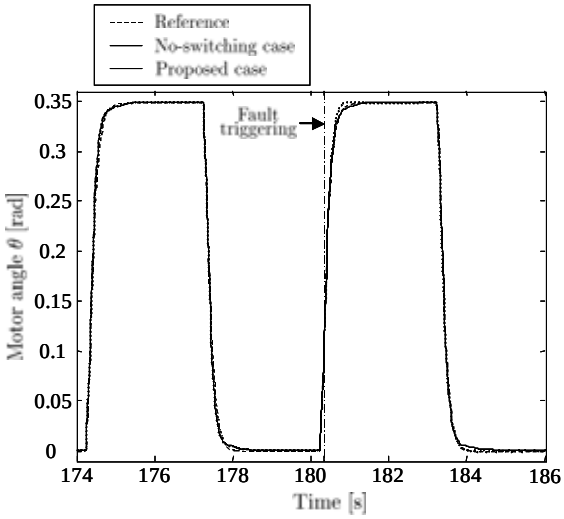

Fig.2 Motor angle θ

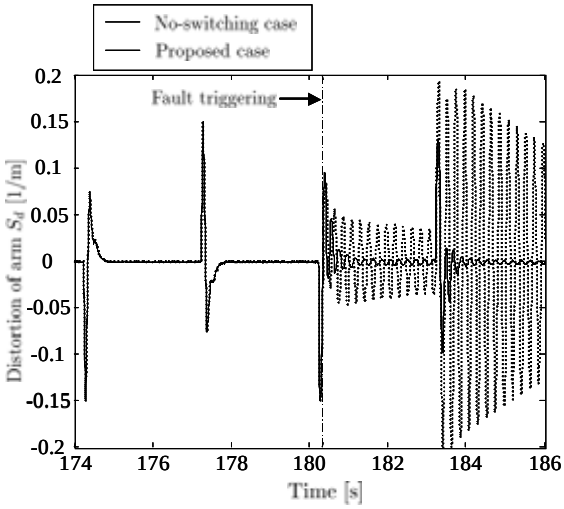

Fig.3 Distortion of arm S_d

4.Conclusion

In this paper, we proposed the fault-tolerant control system for the strain gauge sensor fault. In the proposed system, the strain gauge sensor fault is detected by monitoring the estimation error between the sensor signal and the estimated signal, and the control system works with the estimated signal after fault detection. From some experimental results, we confirmed that the proposed control system could maintain the stability and the control performance after the strain gauge sensor fault.

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Decision Problems for Non-Linear Term Rewriting Systems

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Keywords: Term rewriting system, Decision problem, Non-linear

1. The purpose

A term rewriting system (TRS) is a set of directed equations (called rewrite rules). In this thesis, we consider the following five fundamental decision problems for TRSs:

Joinability problem
For a TRS R and two terms s and t, can s and t be reduced to some common term by applying the rules of R?

Reachability problem
For a TRS R and two terms s and t, can s be reduced to t by applying the rules of R?

Word problem
For a TRS R and two terms s and t, are s and t convertible by applying the rules of R?

Unification problem
For a TRS R and two terms s and t, are s and t unifiable modulo R?

Confluence problem
For a TRS R, is R confluent (Church-Rosser)?

The word and unification problems are most important ones and their decision algorithms have various useful applications in computer science, e.g., logic and functional programming, automated deduction, knowledge-based systems, computational linguistics, deductive databases, and so on. These two problems are closely related to the other ones. For example, the word problem is equivalent to the joinability one if TRSs are confluent. The unification problem includes the word problem as its special case and its decision algorithm often needs an algorithm to decide joinability as its component. However, all of these problems are undecidable in general, so that many researches finding decidable subclasses for them have been made so far. In this thesis, we consider these decision problems for semi-constructor TRSs. Here, a semi-constructor TRS is such a TRS that all defined symbols appearing in the right-hand side of each rewrite rule occur only in its ground subterms. This class is a minimal subclass of non-right-linear TRSs, which include right-ground rules and collapsing rules. The class of semi-constructor TRSs was introduced by us in order to explore the border between decidable and undecidable classes of these decision problems, since few nontrivial non-right-linear subclasses of TRSs which possess these decidable properties have been known so far.

2. The joinability and reachability problems

Joinability and reachability are known undecidable even if we restrict ourselves to flat TRSs. On the other hand, these problems are decidable for some subclasses of TRSs (e.g., right-ground TRSs, right-linear semi-monadic TRSs, and right-linear finite path overlapping TRSs). Many of these decidability results have been obtained by reducing these problems to decidable ones for tree automata, so that these decidable subclasses are restricted to those of right-linear TRSs. In this thesis, we have shown that joinability is undecidable for linear

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semi-constructor TRSs, but by developing a new proof technique, we have shown that this problem is decidable for confluent semi-constructor TRSs and confluent semi-monadic TRSs. It follows that the word problem is decidable for confluent semi-constructor TRSs and confluent semi-monadic TRSs, since the joinability is decidable. We also have shown that reachability is undecidable both for linear semi-constructor TRSs and confluent monadic and semi-constructor TRSs. These results are interesting, since no subclasses of TRSs with the undecidable reachability but decidable joinability problems have been known so far.

3. The unification problem

The unification problem is known undecidable even if we restrict ourselves to either right-ground TRSs or terminating, confluent, monadic, and linear TRSs. On the other hand, it is known that this problem is decidable for some subclasses of TRSs. In this thesis, we have shown that unification for confluent semi-constructor TRSs is decidable. In order to obtain this result, we have developed a new unification algorithm obtained by refining our previous algorithm for confluent simple TRSs, which is a proper subclass of confluent semi-constructor TRSs. A main difference between the algorithms of the present thesis and of the previous works is that the previous ones were constructed using decision algorithms for joinability and reachability, but the present one using only a decision algorithm for joinability. This refinement is necessary to obtain our new result, since reachability is undecidable for confluent semi-constructor TRSs.

4. The confluence problem

We have shown that confluence is undecidable for semi-constructor TRSs. As a related result, it has been reported that confluence is undecidable for flat TRSs. However, we have found that the proof is incorrect, and succeeded in finding a correct proof.

5. Remarks

We suggest the following problems as future works.

1. Finding subclasses of flat TRSs such that reachability is decidable.
2. Finding decidable subclasses of TRSs for unification problem, which properly include the class of confluent semi-constructor TRSs.

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A Study on Energy Saving and Environmental Load Reduction Method for Air-Conditioning System

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Keywords: Heat Pump Unit, Natural Working Fluids, Energy Saving, Humidity, Two-phase Flow Nozzle

1. The purpose

Air-conditioning systems mainly consist of heat source unit, which generate chilled and hot water and air-conditioner, which handle with heating load or cooling load. From the point of energy saving and environmental load reduction, it is important to operate these facilities and keep indoor environment appropriately because its energy consumption rate to the hole building is almost 50%. Reflecting recent social situation, the social concern with environmental load reduction has been growing and we can see some researches try to solve these issues. Aiming to achieve this purpose, two methods have been developed in this study. The one is that development of heat pump unit with ice thermal storage tank using natural working fluids, that is ammonia refrigerant. The other is that indoor relative humidity improvement method during heating operation in winter and development of high efficiency humidifier system using two-phase flow nozzle. The outline of study is shown below.

2. Development and performance estimate in aging change of heat pump unit using ammonia refrigerant with ice thermal storage tank[1)2)]

As global environment problem has become an important issue, ammonia refrigerant has been watched keen interest because it dose not cause destruction of the ozone layer and global warming. We have developed an air-source and water-source heat pump units using ammonia refrigerant with ice thermal storage tank from the perspective for popularizing systems which use natural working energy and natural working fluids. To further popularizing of this system, we have to verify its reliability and safety because ammonia refrigerant is prescribed for toxic and combustible gas in ammonia gas regulations in Japan. In this part, aiming to rationalize of its design, operation and maintenance, we carried out practical study to

Table. Aging change after 5years and performance recovery between before and after overhaul of popularized air-source heat pump unit using ammonia refrigerant with ice thermal storage tank

Classification	Item	Before overhaul	After overhaul
		2002/7/3-4	2002/8/5-6
		Difference †	Difference †
Thermal storage	Ice storage capacity	+2%	+1%
Capacity	Ice packing factor	+1%	+2%
	Ice making capacity (Night time)	-2%	+4%
	Heat pump operation capacity (Day time)	+2%	+16%
Efficiency (COP)	COP during ice making	+11%	+15%
	COP during heat pump operation	+16%	+26%

† Compared with designed value

† Chubu Electric Power Co., Inc.

verify its performance both in development phase and aging change, and results of the field test for verification of its performance are presented. It was found that the heat pump unit using ammonia refrigerant can be handled as well as the heat pump unit using fluorocarbon refrigerant such as HFC.

3. Study on the improvement of indoor relative humidity for office buildings during heating operations in winter[3)4)]

Indoor relative humidity is stipulated for an important point in indoor environment regulations such as Building Control Code in Japan. Based on the findings of indoor environment studies carried out during the winter, however, relative humidity is below standards in many buildings. Aiming to clarify the actual state of indoor relative humidity and improve it during the winter, we have selected sixty-nine office buildings located in Central Japan and carried out a study. We have also investigated actual performance of popular humidifiers that are frequently used in air-conditioning systems. Throughout this study, we classified the factors that degrade indoor relative humidity into two categories. One consists of factors caused by building side such as infiltration and decreased winter loads. The other consists of factors caused by humidifier such as low performance at low indoor temperatures. Given that the winter load in office buildings has tended to decrease because of improvements of building insulation and increasing number of office equipment used in office buildings, almost all the popular humidifier except the steam type failed to maintain performance due to low indoor temperatures. For the reasons mentioned above, we developed a high-efficiency humidifier system that uses a two -phase flow nozzle for industrial use. Because its spray particles are smaller than those of popular spray types, its performance is not affected by indoor air temperature. In this part presents results of the investigation and methods of improvement including development of a high-efficiency humidifier system. Results indicated that about 80% of office buildings studied could not maintain relative humidity to standard during the winter. Relative humidity remarkably improved in office buildings which had a high-efficiency humidifier system using two-phase flow nozzle. If steps are also taken for the building, then relative humidify in office buildings will further improve.

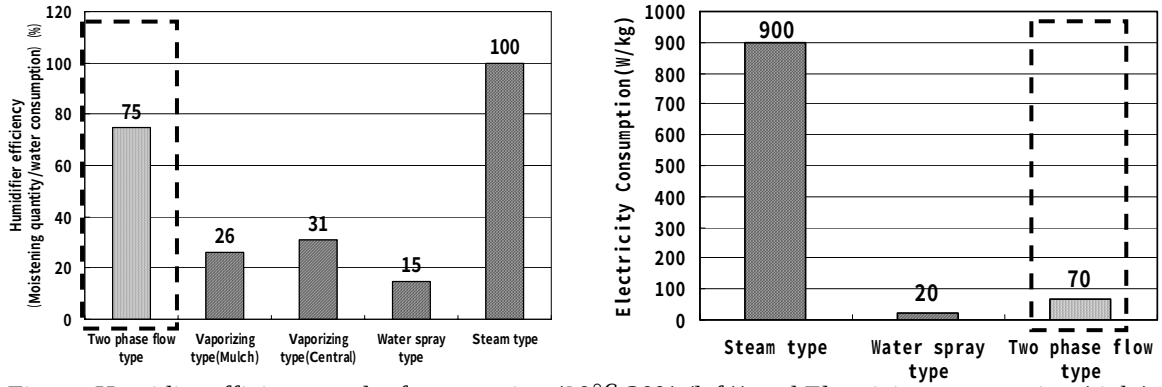

Figure. Humidity efficiency under fan operation (20℃,30% (left)) and Electricity consumption (right) compared with popularized humidifier

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Studies on Performance Improvement of Jet Pump

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Keywords: Jet pump, Single nozzle, Efficiency, Mixing process, Local skin-friction coefficient, BWR

1. Introduction

A jet pump has been widely used in the Boiling Water Reactor (BWR) plant, driven by the PLR (Primary Loop Recirculation system) pump to recirculate the reactor core coolant because of its safety aspect by minimizing the PLR piping diameter and pump flow. The improvement of the BWR jet pump efficiency brings an economic advantage because it reduces the operating power cost of the PLR pump for driving jet flow.

Recently in order to reduce the plant operating cost, improvement of the jet pump efficiency is expected for the first-generation jet pump which efficiency is about 35%. And it is also needed to obtain fundamental knowledge of the effect of surface roughness on jet pump performance in order to recover the efficiency by cleaning jet pumps which are reduced by attached crud such as iron oxide or chromium oxide inner-surface of the jet pump. Especially, it is important to specify the effect of the rough location in the throat because throat has long length to mix the driving jet and the induced flow. In order to improve and recover the efficiency of the BWR jet pump, experimental studies are performed for a typical single nozzle jet pump using water at room temperature condition and a small-scale model.

2. Experiment and Results

Figure 1 shows the experimental set-up of the jet pump performance tests. High pressure water pumped by a centrifugal pump flows into the nozzle as the driving jet flow. The driving jet and induced flow are mixed in the throat and flow out after recovering pressure in the diffuser. Figure 2 shows the normal throat for improvement test and the rough location test, and the diverging throat for improvement test.

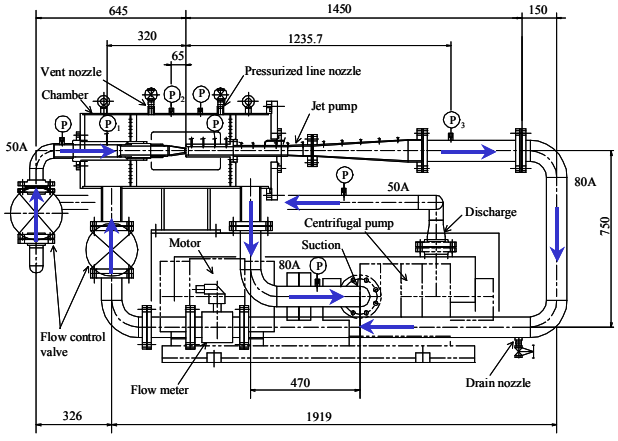

Fig. 1 Experimental set-up of jet pump performance tests

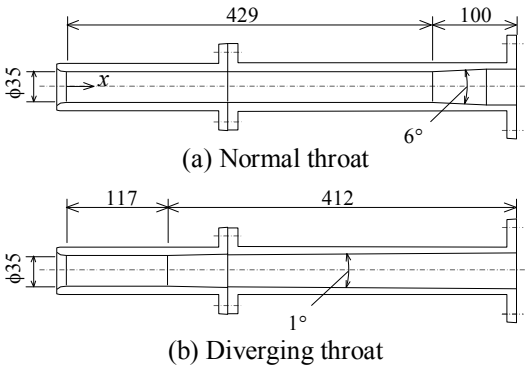

Fig. 2 Throat shapes

† TOSHIBA CORPORATION Power Systems Company

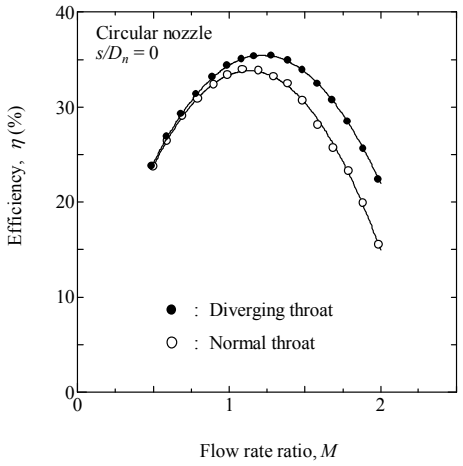

Fig. 3 Effect of throat shape on efficiency

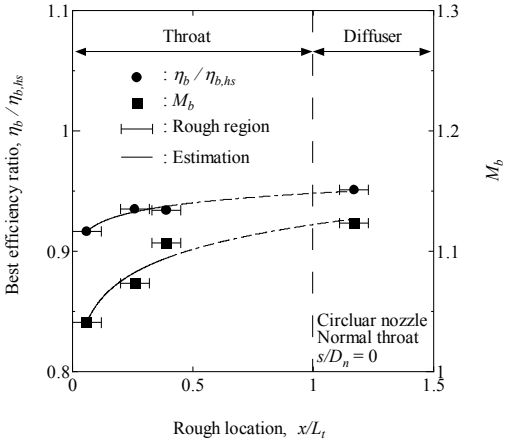

Fig. 4 Effect of rough location on the best efficiency

Figure 3 shows the effect of the throat shape on the jet pump efficiency η. The efficiency of the diverging throat is improved about 2% compared with the normal throat. The results of flow analysis (CFD) show that divergence angle of about 1 deg is optimum and almost the same improvement of efficiency is expected at BWR operating condition. Figure 4 shows the effect of rough location on the flow rate ratio M_b at the best efficiency point and the best efficiency ratio $\eta_b / \eta_{b,hs}$, where $\eta_{b,hs}$ is the best efficiency of the hydraulically smooth jet pump. M_b and η_b are decreased rapidly as rough location x/L_t is closer to the throat inlet. From the velocity profile measurement results in case of hydraulically smooth throat, local skin friction coefficient C_f tends to decrease toward the throat exit and then increase after the transition to the turbulent boundary layer. Apparently roughness in the throat inlet where C_f is larger greatly affects jet pump efficiency.

3. Concluding remarks

i) The efficiency of the diverging throat is improved about 2% compared with the normal throat.
ii) The results of the flow analysis show that divergence angle of about 1 deg is optimum for diverging throat and efficiency improvement of the diverging throat is expected at BWR operating condition.
iii) Surface roughness located nearer the throat inlet has a greater effect on the jet pump efficiency because the local skin friction coefficient nearest the throat inlet is the larger. Therefore cleaning the throat inlet is the most effective to recover the jet pump efficiency.

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A Study on Extraction Method and Waterfront Area Improvement for Designing Irrigation Reservoir as Urban Parks

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keywords: Reservoir, Parks, Extraction Method, Waterfront Area Improvement

1. INTRODUCTION

Open spaces with green and water are essential in helping to built healthy urban environment by improving air quality and providing recreational opportunities for urban lifestyle. Reservoirs are manmade lakes with the primary objective of storing water for irrigation, power generation and a host of other activities. Therefore, irrigation reservoirs have the possibility to play a significant role to enhance the urban environment. In order to find information needed to design irrigation reservoir as urban parks, the objectives of this thesis are: 1) To classify and extract irrigation reservoirs with conditions for an improvement planning, 2) To clarify characteristics of recreational activities at reservoirs waterfront area and, 3) To analyze the design of waterfront area improvement for enjoying the benefits (characteristics) of reservoir　and its surrounding(water front area).

2. EXTRACTION OF IRRIGATION RESERVOIR FOR IMPROVING AS URBAN PARKS

Chapter two describes a method of extraction of reservoir for improvement planning, especially as urban resources. The area of search is Northern Chita Peninsula.　Five common factors were extracted from 14 variables related to reservoir through factor analysis. In order to classify reservoirs, factor scores were adapted to clustering analysis. By comparing the factor score structure from reservoirs and those with improvement projects, it was possible to extract reservoirs, which has possibilities for an improvement planning. Furthermore, by checcking the relationship between reservoirs extracted from the latter classification, for an improvement planning, and from the former clustering, it was possible to indicate improvement methods from the view point of combining and enhancing the use as agricultural facility for irriagtion and as environmental resource.

3. CHARACTERISTICS OF RECREATIONAL ACTIVITIES AT RESERVOIRS' WATERFRONT AREA

In Chapter tree, characteristics of recreational activities at reservoir's waterfront area are investigated. Two sorts of survey were carried out to compare users' characteristics and recreational activities between a park with reservoir and another without reservoir. In a park with reservoir, passive recreational, active recreational and walking were observed at waterfront area, which includes the walking path and the bank. Walking was the dominat recreational activitiy in this area and the majority of this recreational activity was daily or weekly – elderly users. Users that came to walk in a park with reservoir were more and stayed longer than in a park without reservoir due to opportunities for enjoying the aesthetical quality that the reservoir and the environment provide.

4. DESIGN OF WATERFRONT AREA IMPROVEMENT FOR ENJOYING RESERVOIRS' BEFENITS

In Chapter four, relations between places to watch and places to be watched are investigated in order to clarify design improvements that attend the needs of reservoirs' (waterfront area) users. Places to watch are

located in places with good accessibility and goob visibility. Accessibility is related to the surrounding land use, such as parks, parking areas and access road. And visibility is related to the open space effect and the natural diverse edge. The design of places to watch should attend the needs of users with good visibility and attractiveness; however, a precise location is necessary to not disturb the environment at the waterfront area coexisting with the natural diversity.

5. CONCLUSION

The conclusions obtained from each chapter is as follow:

Chapter two: 1) 5 common factors (dimension, location, accessibility, aesthetical quality and maitenance condition) were extracted from 14 variables related to reservoir through factor analysis. In order to classify reservoirs, factor scores were adpted to clustering analysis. Reservoirs were classified in 5 big patterns: [big reservoirs], [irriagtion reservoirs in rural areas], [residential proximity reservoirs in rural areas], [small urban reservoir], [small rural reservoir]. 2) In the area of search, almost 20% of reservoirs were improved as parks or as 'rural improved projects'. By comparing the factor scores structure from reservoir and those with improvement projects, it was possible to extract reservoirs, which has possibilities for an improvement planning. 3) Furthermore, by checking the relationship between reservoirs extracted from 2), for an improvement planning, and from 1), it was possible to indicate improvement methods from the viewpoint of combining and enhancing the use as agricultural facility for irrigation and as environment resource.

Chapter tree: 1) Walking is the dominant recreational activity at the reservoir's waterfront area. The majority of this recreational activity is daily or weekly elderely users. 2) Recreational activities can be classified in 7 patterns: one pattern is single purpose activity and 6 patterns are multiple purpose activities. 3) Pattern 1 (walking), pattern 6 (walking + chatting) and pattern 7 (others) are common patterns in both parks. Patterns 3,4 and 5 which are walking + watching the scenary are specific from the park with reservoir. 4) For users from patterns 3,4 and 5, richness of green, fauna anf flora, and the water surface are reasons to use the park. These are related to aesthetical quality that the reservoir and the surrounding provide.

Chapter four: 1) Places to watch can be categorized in 7 elements: walking path (circle and non-circle), deck , bridge, adjacent park, kiosk, terrace and lower terrace. Places to be watched can be categorized in 5 elements: water plant, background, decorated bank, planting and 'oasis garden'. 2) Decks, terraces and kiosks are located along the walking path, and close to places where users concentrate or easy to access, such as entrances, access road, parking area or adjacent park. 3)Furthermore, 'places to watch' are also located in places with good visibility: places where users can contemplate the open space effect and the natural diverse edge of reservoirs. And the diverse edge can be divided in preserved green area and improved green area. 4) The design of walking path should also attend the needs of users with good visibility and attractiveness; however, the location should be precise to not disturbe the environment at the waterfront area coexisting with the natural diversity.

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Separated Flow through Channel/Pipe with Abrupt Change of Cross-section
—— Flow Control and Drag Reduction——

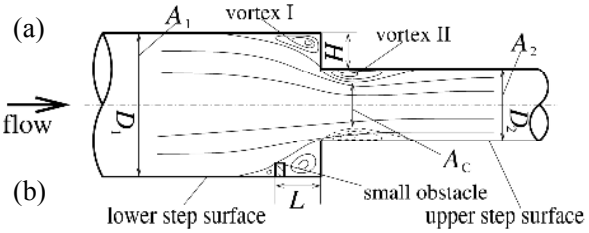
Toshitake Ando*

Keywords: Abrupt contraction/expansion pipe, Forward/backward facing step, Drag reduction, Flow separation, Flow control

1. Introduction

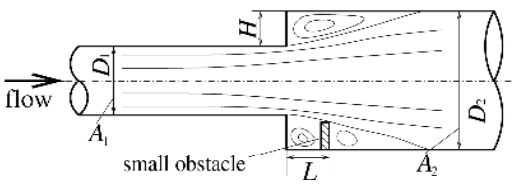
The flow through the pipe which has an abrupt change of cross-section has an annular vortex region just after the abrupt change [Fig.1 and 2(a)]. The negative pressure in this region causes a magnificent flow resistance. Some flow control is needed to reduce the flow resistance of this kind of flow. In this study, the reduction of the flow resistance by mounting a small ring shaped obstacle on the pipe wall [Fig.1 and 2(b)] is newly shown and examined. This is a simpler method than using diffuser, especially for a large scale pipe or duct system.

Two-dimensional forward-facing step is contained in the abrupt expansion pipe. For the first, the control of the vortex region on the upper step surface of two-dimensional forward-facing step by small obstacle (rectangular column) was examined. Next, reduction of flow resistance (drag) of abrupt contraction pipe by ring shaped small obstacle was examined. Abrupt expansion pipe which has opposite shape of abrupt contraction pipe was also examined. Experiments was carried on using water.



(a) without small obstacle
(b) with small obstacle

Fig. 1 Abrupt contraction pipe



(a) without small obstacle
(b) with small obstacle

Fig. 2 Abrupt expansion pipe

2. Experimental Results

Figure 3 shows the stream lines of th flow over the forward facing step. Reynolds Number is Re = $U\ H\ /\ \nu$ = 5,000 (U: velocity, ν: kinematic viscosity). The rectangular column of h = 0.2H height is mounted on the lower step surface at $L\ /\ H$ = 3.5. In this case, vortex region on the upper step surface is suppressed because separated flow from the rectangular column flows along the upper step surface. This simple method is applied to the abrupt contraction and expansion pipe to reduce the flow resistance (drag) ζ [= 2 Δp / (ρU_1^2) where Δp: pressure loss at expansion, ρ: density, U_1: mean velocity in upstream pipe]. Figure 3 and 4 show the flow resistance (drag) in the cases of abrupt contraction and expansion pipe, respectively. In the case of abrupt contraction, pressure difference $|\Delta Cp|$ [= 2 Δp / (ρU_1^2), where Δp pressure difference] takes minimal value at $L\ /\ H$ = 1. In the case of abrupt expansion pipe, the flow resistance ζ takes the minimum value in the case of $L\ /\ H$ = 5 and $h\ /\ H$ = 0.8.

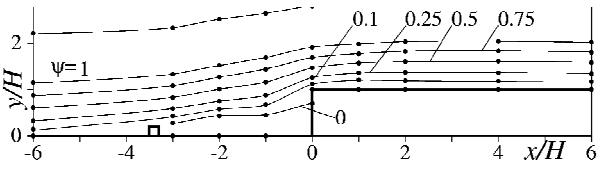


Fig. 3 Control of the separation flow on the upper step surface of forward facing-step (Re = 5,000, $L\ /\ H$ = 3.5, $h\ /\ H$ = 0.2)

*Mie University

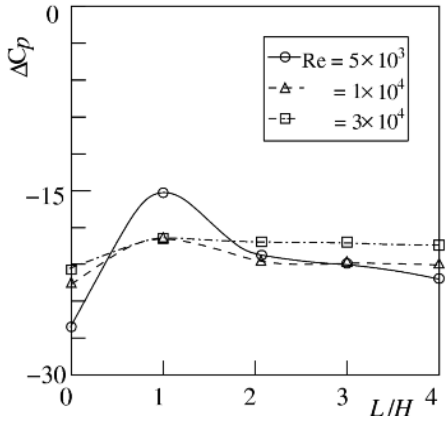


Fig. 4 Flow resistance of abrupt contraction pipe ($A_1/A_2 = 4$, $h / H = 0.4$)

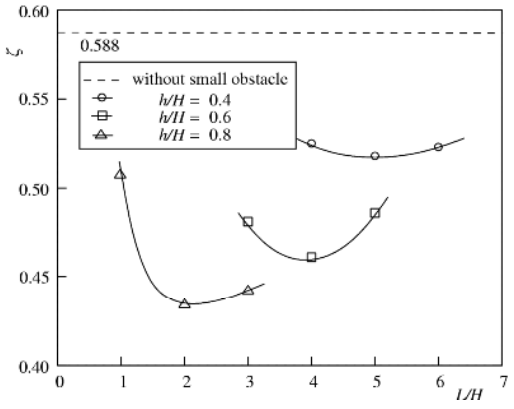


Fig. 5 Flow resistance of abrupt expansion pipe ($A_2/A_1 = 4$, Re=100,000)

3. Conclusion

Some major results are as follows:

(1) The vortex region on the upper step surface of forward-facing step can be suppressed by mounting a small obstacle (height: 0.2*H*) on the lower step surface. The size of vortex is decreased with increasing L / H, and at $L / H = 3.5$ it disappeared almost because the separated flow from the small obstacle flows along the upper step surface.

(2) The flow resistance of abrupt contraction pipe takes a minimum value for mounting a ring shaped small obstacle on upstream pipe wall (lower step surface) at $L / H = 1$ because vortex region on the downstream pipe (upper step surface) is suppressed. The reduction rate of flow resistance is 16% for the pipe of contraction rate $A_1 / A_2 = 4.0$.

(3) In the case of abrupt expansion pipe of expansion rate of $A_2 / A_1 = 4.0$, the flow resistance takes a minimum value for mounting a small obstacle of $h / H = 0.8$ on down stream pipe wall at $L / H = 2.07$ because vortex region on the downstream pipe is make waken. The reduction rate of flow resistance is 26%.

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