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Numerical investigation of heat transfer and pressure loss of flow through a heated plate mounted by perforated concave rectangular winglet vortex generators in a channel

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Abstract

The low thermal conductivity of air in fin-and-tube heat exchangers causes high thermal resistance of the air side and results in a low heat transfer rate. This heat transfer rate on the air side can be improved by increasing the heat transfer coefficient. One way to increase the heat transfer coefficient

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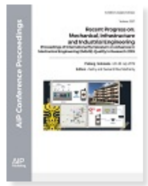

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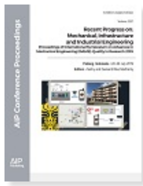

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BROWSE VOLUMES

Numerical Investigation of Heat Transfer and Pressure Loss of Flow Through a Heated Plate Mounted by Perforated Concave Rectangular Winglet Vortex Generators In a Channel

Syaiful[1, a)], Nakula Kusuma[1], Muchammad[1], Retno Wulandari[2] , Nazarudin Sinaga[1], Ahmad Siswantara[3] , Myung-Whan Bae[4]

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Abstract. The low thermal conductivity of air in fin-and-tube heat exchangers causes high thermal resistance of the air side and results in a low heat transfer rate. This heat transfer rate on the air side can be improved by increasing the heat transfer coefficient. One way to increase the heat transfer coefficient on the air side is to use a vortex generator (VG), which can generate longitudinal vortex (LV) increasing fluid mixing. Therefore, this study aims to numerically analyze heat transfer characteristics and pressure drop of airflow through a heated plate by installing VG in a rectangular channel. Vortex generators (VGs) used in numerical modeling are rectangular winglet pairs (RWPs) and concave rectangular winglet pairs (CRWPs) with 30° attack angle. The number of pairs of VG is varied by one, two, and three with/without holes. The velocity of airflow varies in the range of 0.4-2.0 m/s at intervals of 0.2 m/s. The simulation results show that in the configuration of the three pairs of VG, the decrease in the convection heat transfer coefficient in the case of the perforated CRWP is 3.98% of the CRWP without holes at a velocity of 2.0 m/s. While in the configuration of three pairs of perforated RWP VGs, the decrease in convection heat transfer coefficient is 5.87% from RWP without holes at a velocity of 2.0 m/s. In the configuration of three pairs of perforated VGs at the highest velocity, the decrease in pressure drop in the CRWP and RWP cases is 30.73% and 13.87% of the VGs without holes, respectively.

*Keywords***:** Heat transfer; Pressure loss; Perforated concave rectangular winglet; Longitudinal vortex intensity; Field synergy principle

INTRODUCTION

Compact heat exchangers (CHXs) are widely used in the chemical industry, petroleum industry, automotive industry, refrigeration industry, and others. Fin-and-tube is one type of compact heat exchanger that is widely used, especially in household cooling (Awais and Arafat, 2018). The low thermal conductivity of the air causes a high thermal resistance on the air side and results in a low heat transfer rate (Zhan et al., 2018). This heat transfer rate on the air side can be improved by increasing the heat transfer coefficient (Zeeshan et al., 2018).

Increasing the rate of heat transfer can be done by three methods, namely active, passive, and combined. The difference between active and passive methods is in external power (Han et al., 2018). Active methods such as fluid vibrations, surface vibrations, electroscopic fields, and suction layer boundaries require external power to increase the heat transfer rate, while the passive method does not use the external power to increase the heat transfer rate (Awais and Arafat, 2018). Thepassive method by extending the surface and coating the surface is more cost effective and easy to use compared to the active method. Therefore, increasing the heat transfer rate with the passive method is more widely used in research (Liu et al., 2018).

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A Comprehensive System for Management Roadway Infrastructure

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Abstract. Utility infrastructure assets in the United States continue to grow as millions of utility features were installed within the properties of state and local agencies. With this growth, the management of the utility data records is becoming a complex problem in terms of large amounts of data. On one hand, management of data for utility infrastructures is extremely valuable to state and local agencies because the timely access to utility-related information is a significant requirement for the delivery of construction and renovation projects on time and within budget. On the other hand, many challenges arise, such as difficulties in effective data storage of complex and messy datasets, data analysis, and data visualization. Utility owners face challenges in collecting utility data in standardized formats, data storage, and providing easy access to all stakeholders. Using a case study in Nevada, this paper demonstrates how tools and a strategic workflow process can be harnessed to develop an end-to-end management solution for large and complex data of a utility infrastructure. This end-to-end utility data management solution builds upon existing systems which are not adequate for large utility data management because they are non-scalable, do not allow for access by multiple users, involve manual data uploads, do not control consistency of data attributes, and lack visualization tools for non-GIS experts. In addition, they do not provide an end-to-end data management pipeline from data acquisition, through data integration, quality control, storage and finally to data access. The developed system in this case study was used for an end-to-end management test of large data during the testing phase and proved to perform seamlessly. Our approach could be adopted by other utility jurisdictions to manage their utility data. Such a data management system allows for automated and proper management of utility data thereby helping state and local agencies reduce utility conflicts and offset construction costs due to utility damages. This data could be combined with other rich data sources, such as financial data, and mined for valuable, hidden insights.

INTRODUCTION

Data-driven decision-making is becoming feasible on a broad scale, and there is growing enthusiasm for a wide range of applications of big data. The definition of 'big data' is relative, and depends greatly on the context in which it is used. Usually, big data includes data sets with sizes beyond the ability of commonly used software tools to capture, manage, and process information within a tolerable length of time (1). Some have defined big data as a set of techniques and technologies that require new forms of integration to uncover large hidden values from large datasets that are diverse, complex, and massive (2).

Geographic Information System (GIS) utility datasets are characterized by volume, complexity, and variety. State and local agencies manage huge utility infrastructure assets that consist of millions of utility features installed within their right-of-ways (ROW) (3).These datasets typically are stored as shape files, geo databases, Computer Aided Design (CAD) documents, image files, Extensible Markup Language (xml) files, and Portable Document Files (PDF),

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Numerical Analysis of General-Vibration-Based method for Structural Health Monitoring

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Abstract. For damage detection, this research article discusses an easy-to-compute damage index derived from the governing dynamic of the structure that has potential practical application in Structural Health Monitoring (SHM). The research uses simplified structural models to explore the sensitivity of the index to damages, to compare the index performance with a traditional but popular damage detection method, and to understand the local/global predictive capability of the index. The research uses two simple models, namely, single- and two-degree-of-freedom systems. The results suggest that the damage index is local, that can only monitor damages occurring near the points of measurements, but it is sensitive to damages, unlike the natural frequency, which is global but less sensitive.

Keywords**:** Damage Index; General Vibration Method; Mode Shape; Natural Frequency; Structural Health Monitoring

INTRODUCTION

Determining features of engineering structures sensitive to structural damages has become a very active research topic in the area of Structural Health Monitoring (SHM). The features are commonly extracted or derived from the structural deformation or rate of deformation data. The most widely used features are the structural natural frequencies, mode shapes, deformation curvatures, the Power Spectral Density (z and F statistics), and other features derived from those quantities (Xu, Brownjohn, and Hester, 2019; Perez and Serra-Lopez, 2019).

The natural frequency and mode shape are advantageous and practical for damage detection. The quantities can be estimated from data obtained at a few measurement points and are theoretically capable of changing with damages that occur on any part of the structure. The quantities are global. Our understanding of the quantities and their measurement methods are well established. With those characteristics, the quantities are widely used for damage detections.

During the last decade, the authors witness the proliferation of the use of machine learning or soft computing techniques for SHM applications. The machine learning techniques are often used in conjunction with those damage sensitive features as the input data (Chang, Lin, and Chang, 2018; Gunawan, 2018; Gomes, Junqueira, da Cunha, and Ancelotti, 2019). However, the authors also witness the use of the techniques with raw data directly measured from the structural deformation. In this approach, the features are not explicitly derived but are established as an integral part of the techniques (Zhao, Yan, Chen, Mao, Wang, Gao, 2019; Khodabandehlou, Pekcan, and Fadali, 2019). For example, Khodabandehlou, Pekcan, and Fadali (2019) developed a convolution neural network model that classified

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Characterization of Homemade UV-LED Photolithography to Realize High Aspect Ratio Channels

Rayzi Rizqika[1], Yudan Whulanza[1,2, a)], Jerome Charmet[3], Gandjar Kiswanto[1], Tresna P. Soemardi[1]

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Abstract. The ultraviolet light-emitting diode (UV-LED) photolithography has been developed since the last decade. This technology has been massively used to a microfluidic device. Generally, a complex instrument needs to be installed to fabricate such desired microfluidic devices. However, it would be an intensive investment to do so. Therefore, a low-cost photolithography is preferably compared to that conventional system that expensive and requires additional infrastructures. Here, we reported the result of our homemade UV-LED photolithography in realizing microfeature as we desired. However, a series of experiments are needed to find the optimum process parameter to have the best result. Moreover, our system achieves a 3D feature with 40-240 um thick, 40-140 um channel width, and aspect ratio until 3.5. These findings shall meet the requirement of various microfluidic applications.

INTRODUCTION

Microfluidic technology has been known to be applied in a wide range of applications in life science such as micro total analysis system [1,2], lab-on-chip [3-5], organoid chip [6-7], drug delivery system [8-10]. It has the main benefit that the system requires fewer reagent quantities, thus reduces reaction time. However, this microfluidic system needs a high-precision fabrication method to deliver a proper performance. Generally, the method is using photolithography techniques, which readily available as expensive instrument setup [11,12]. This high investment caused by their complex components such as high-pressure mercury lamps and requires a specific room environment [13].

Current research shows that the usage of an ultraviolet light-emitting diode (UV-LED) has great potential to replace the conventional lithography setup [14-17]. The power of LED has reached 100 times at a much lower price compared to a decade ago [18,19]. However, the system resulted in features that were in the range of 20-100 um and reached aspect ratio (height to lateral size) of 14 [20]. The most recent report showed a feature size of 80 nm by using this similar technology [21].

Here, we use a UV-LED photolithography system inspired by a simple and low-cost setup from Charmet Lab [22] to complete our lab setup [23-25]. They introduced a setup that uses commercial components that easily found in the market. However, we would like to continue the characterization in terms of the effects of proximity setup, exposure duration, and photo masking arrangement. Ultimately, we would like to realize a microchannel system that resulted from mold transfer to elastomer polydimethylsiloxane in a various biological microfluidic system.

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