MPhil / PhD.
Project Synopsis 2019

Dr. Mohamed Sukri Mat Ali
✉sukri.kl@utm.my
Wind Engineering Laboratory
Malaysia-Japan International Institute of Technology (MJIIT),
UTM Kuala Lumpur, 54100 Kuala Lumpur.

July 2, 2019

Contents

1 Min. Admission Requirements

Criteria	CGPA	English	Publications
M.Phil	3.0	Muet 3	-
PhD.	3.0	Muet 3	1 Scopus

2 Output Graduation Requirements

Criteria	Publication/Year	Publication/Candidature
M.Phil	1 Conference	1 Q3/Q4
PhD.	1 Scopus	1 Q1/Q2

3 Incentive

Program	Monthly Allowance
M.Phil	RM 1800
PhD.	RM 2300

4 Aerodynamics

4.1 Flow over a bluff body with a downstream body

Flow over a bluff body is the fundamental aspect in the understanding the physics of flow for more complex geometries. The evolution of Kármán Vortex is responsible for the generations of fluctuating forces and prominent aeolian tone. This study is to numerically/Experimentally analyse the effects of downstream body on the instability of the wake. The findings of the study can be applied for side rear view mirrors of passenger cars, bridge piers, offshore oil platform cylinders and etc.

4.2 Mechanisms for Flow Induced Vibration of Interfering Bluff Bodies for Micro Energy Harvesting System.

Aerodynamic instability such as vortex induced vibration (VIV) and galloping has been described as problematic phenomenon by many researches. It is an unstable state caused by oscillation of a structure induced by the periodic fluctuations in the flow near the wake when fluid passes a cylindrical bluff body. However, in recent years the feasibility of this phenomenon to harvest electric energy for low-power electronic devices has been investigated and practically proven to be possible for higher branch of wind velocity. Recent challenge is to find the best configuration of the energy harvester and consequently overcome the limitation for lower branch of wind velocity.

Square cylinder has accessed to both VIV and galloping, which shows a good potential to produce more energy than the circular cylinder. VIV is an aerodynamic instability which occurs at relatively low onset velocity, while galloping produces relatively high amplitude but occurs at later onset velocity. The behaviour of VIV is much simpler to be predicted compared to galloping due to its complicated and irregularities behaviour. Hence, series of numerical simulations using OpenFOAM package will be conducted to investigate the physics of flow and the fundamental interaction between flow and cylindrical bluff body. A downstream flat plate will be included in the configuration as a passive vibration control assumed to be a magnifier for the vibration.

The main goal of this project is to investigate the feasibility of a square cylinder with and without a downstream flat plate to harvest energy when mounted on spring with damper that is freely oscillating in a transverse direction to the incoming flow. This project may contribute to the forthcoming research in fluid dynamics and microelectronic electronics. Besides, this project will also expedite the energy harvesting application as a replacement for finite-lifespan batteries to power low electronic sensors.

4.3 Simulation of Food Drying Process using OpenFOAM on Various Stack Arrangement

Computational fluid dynamics (CFD) is a tool used to study the numerical approach and data structure analysis by solving the problems regarding fluid flows, including heat and mass transfer for drying process of food products (such as vegetables and fruits) while maintaining their nutrients as the foods being dehydrated. The mechanisms of food drying are very critical and complex in addition to lack of knowledge in the processes and limited efficiency of research study in the fields using CFD because of inadequate information about each food physiochemical properties and complexity of obtaining experimental data in some dryer designs and condition for validation purposes. Although there are limitations, commercial CFD has successfully simulated the code for the drying process. However, the study using commercial CFD can be very expensive due to high computational power requirements especially in food processing, lead to high food production cost causing high end-price value of food in the market. But in the presence of OpenFOAM, which is an open-source CFD platform, can reduce the cost because it is free and will be quite helpful software for drying process simulation regardless of few research exploration has been done in the fields, currently. Thus, the objectives of this research are to develop CFD code for drying process using OpenFOAM and to find a stack of configuration for optimum drying of food process. The expected result is for OpenFOAM to simulate food drying process as per commercial software successfully. With this, food drying process development can be massively accessed and explore for any research interest, added advantages to the improvement of food technologies in any field.

4.4 Aerodynamic Performance And Safety For A Proposed Malaysia High Speed Train Travelling Under Crosswinds

Malaysia is committed to achieve a developed nation by 2020. To achieve that, an economic transformation programme has been established on September 16, 2009 to transform the current status economy of Malaysia into a high-income nation by 2020. Twelve National Key Economic Areas (NKEAs) have been identified as the engines growths drivers; one of them is the Greater Kuala Lumpur. To rationalise the Greater Kuala Lumpur, the Performance Management and Delivery Unit (PEMANDU) has proposed a high speed train system connecting

Kuala Lumpur and Singapore. The proposed project is motivated by this highly technology demanded project. It is the intention of this proposed project to focus only on the aerodynamics performance and it associated safety concern accompanied by a high speed train. The proposed project can bring benefits to the high speed train technology by increasing the energy efficiency, safety of the high speed train and durability of the components of the high speed train. These can be achieved by identifying the aerodynamics characteristics of the train that then improving the design geometry of the high speed train accordingly

5 Aeroacoustics

5.1 Aeroacoustic Analysis of An Airfoil With Serrations

Noise generation in airfoil is of concerns in many engineering applications, such as aircraft, submarine, and wind turbine. Principally, the sound generation takes place at both leading edge (LE) and trailing edge (TE) of the airfoil. The LE noise, or in some case, it is often referred to the airfoil-turbulence-interaction (ATI) noise, can be a dominant noise source if the airfoil is subjected to a high intensity turbulence. Acoustic performance of an airfoil can be improved with the serrated leading or trailing edge. A sawtooth plate is one of the serration shapes. In this study, the effect of sawtooth plate thickness on the aerodynamically generated noise in wake-sawtooth plate interaction will be numerically (OpenFOAM + Matlab or Octave) investigated.

5.2 Numerical study of a passive noise control using a flat plate for bluff body applications

The dipole noise radiating from flow over a cylinder can be cancelled out theoretically by placing a flat plate downstream of the body. However, the plate can change the instability of the wake. This study is to investigate the possibility of using a flat plate for passive noise control by changing the position and geometry of the plate. Side view mirror of passenger cars, landing gear system of aircraft and pantograph system of high speed train can benefit from this study. Therefore, the study of liquid draining process needs to be revisited to understand in detail the fundamental physic flow of the generation of the air-core vortex.

5.3 Aerodynamics loading and Noise emissions from a high speed train

When trains moving at high speed, the aerodynamics and airborne noise become a significant concern, that is very similar to the aircrafts. A study on the various shapes of high speed train on the characteristics of aerodynamics loading and airborne noise is beneficial in the design process of a high speed train. This is in-line with the National Key Area: Greater Kuala Lumpur, that proposes a high speed train moving at 250 to 450 kmph connecting Singapore and Kuala Lumpur.

5.4 Passive Noise and wake control of flow over a protruding cylinder

When flow past a truncated cylinder a very complex flow structure is generated. This study requires detailed investigation on the generation of four main structures, i.e., horseshoe vortex, tip free shear layer, sides free shear layers and trailing vortices. How these flow structures influence the generation of noise is also will be investigated thorougly. After the full investigation of the single protruding cylinder, a rigid flat plate is placed downstream of the cylinder. The geometry and location of the plate may varies to see the effect of these parameters on wake and noise generations. Numerical simulation is necessary and experimental work requires collobration with other universties.

5.5 Flow and noise associate with a vortex-fluttering plate interaction

A periodic vortex with strong energy is generated when flow past a bluff body above its critical Reynolds number, $Re_c \sim 50$. This energy may be extracted to generate a renewable energy by wind induced motion mechanisms. One of the possibility is by placing a moveable flat plate downstream of the cylinder. However, the vortex-plate interaction may create fluctuations of aerodynamics loadings and radiating noise. This study intends to investigate the effects of vortex-fluttering downstream plate on the flow structure and noise radiation. The fluttering properties of the plate may varies according to the spring stiffness, damping ratio, plate geometry and mass of the plate. Again, numerical simulation is compulsory and experimental work requires collobration with other universties.

5.6 Aeroacoustics refinement of a passenger car DrivAer for NVH improvement.

Interior noise of a production car is a total contribution mainly from engine, tyres and aerodynamics. At high speed, wind noise can dominate the total interior noise. Wind noise is associated with the unsteadiness of the flow. For most production cars, A-pillar and side view mirror are the regions where the highly separated and turbulent flows are observed. This study quantifies the wind noise contribution from A-pillar and side view mirror with respect to the interior noise of a generic realistic model, DrivAer. The noise sources are obtained numerically from the flow-structure interactions based on the unsteady Reynolds averaged Navier stokes (URANS) while the noise propagation is estimated using Curles equation of Lighthill acoustic analogy. The sound pressure frequency spectrum of the interior noise is obtained by considering the sound transmission loss from the side glass by using the mass law for transmission loss.