NOVEL BIO-HYBRID DRAG INDUCED WIND TURBINE

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1. BACKGROUND

In the world of rapid growing economy, energy consumption by power industry and human are drastically rising which is leading to an energy crisis situation. Today several countries are investing their resources on the development of renewable energy; wind power generation.

1. Pollution
Increasing carbon emission by industry and humans activities had impacted global climate which lead to increasing greenhouse gases at the atmosphere year by year regardless the campaign and regulations initiated by the government and NGO.

2. Wind turbine's design for low-wind speed
Design modification were done on wind turbine by engineers in order to adapt the wind speed of the desired geographical area. Researches indicates that, drag driven wind turbines such as Savonius and Darrieus VAWTs are suitable in harvesting wind energy in low wind speed potential.

2. METHODOLOGY

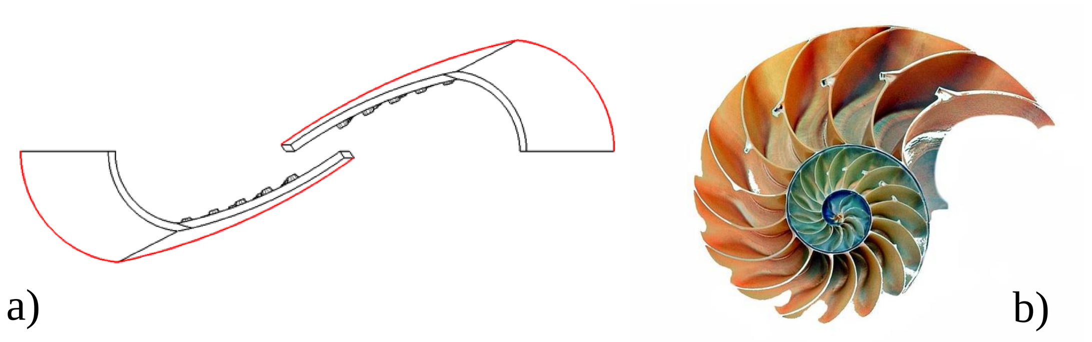


Fig 1. Blade design adaptation:
a) Spiral blade design (top-view), b) Nautilus shell.

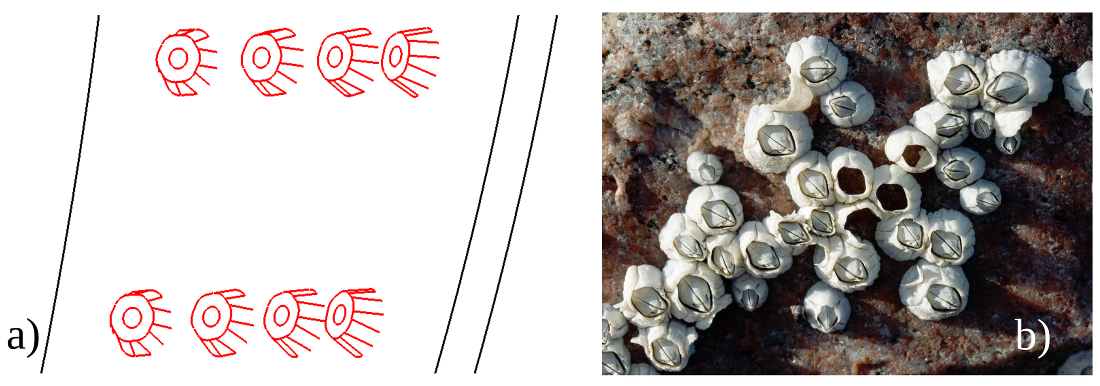


Fig 2. Blade design adaption:
a) Barnacle based skin on blade surface, b) Barnacle.

3. DESIGN PARAMETERS

In this study, the governing shape of the WT namely semicircle and spiral is analyze in order to extract the fundamental numerical factor that influence the shape. The numerical factor is adapted for the construction of the proposed blade morphology. It if found that the proposed conjecture $(\sqrt{2}+2)$ provides an alternative approach in parametrically constructing proposed blade morphology.

$$\text{Proposed conjecture} \equiv R{:}L = \sqrt{2}+2$$

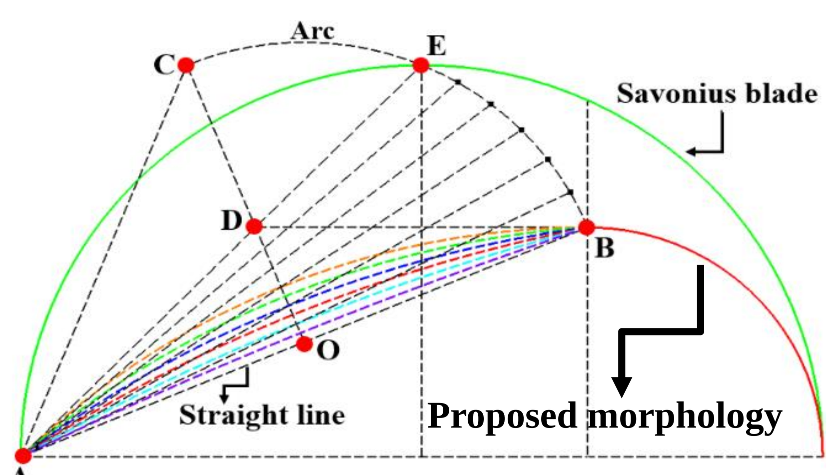


Figure 3. Blade configuration.

4. DESIGN ATTRIBUTES

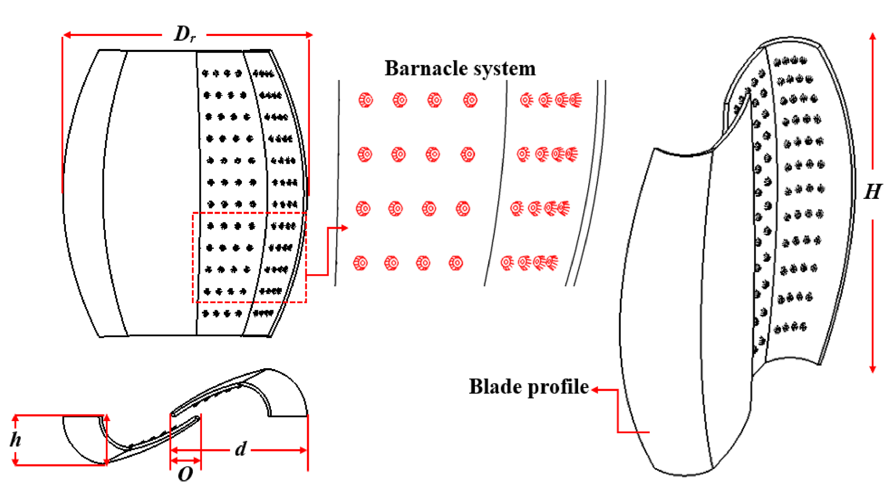


Figure 4. Proposed design configuration.

5. SIMULATION RESULTS

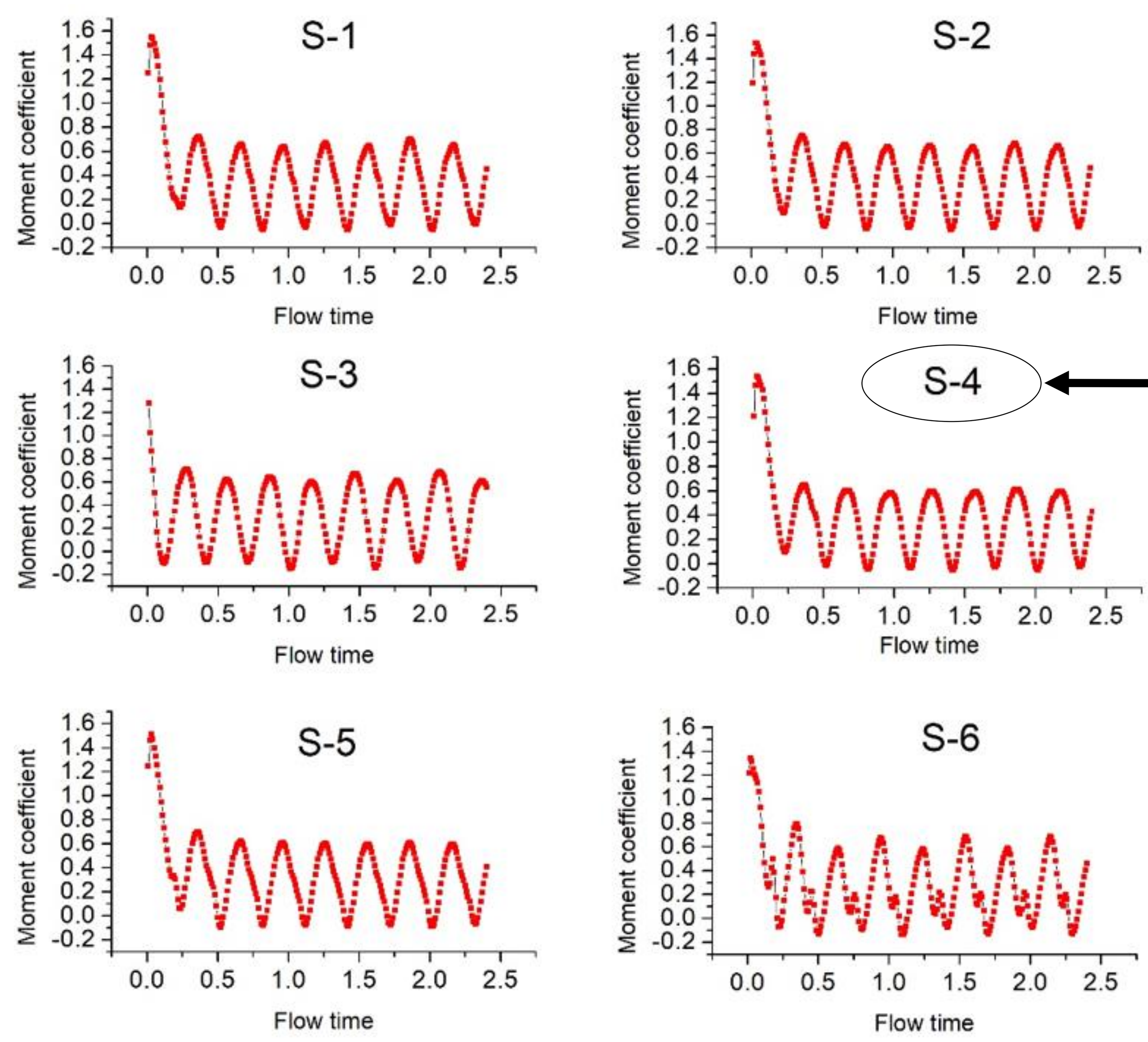
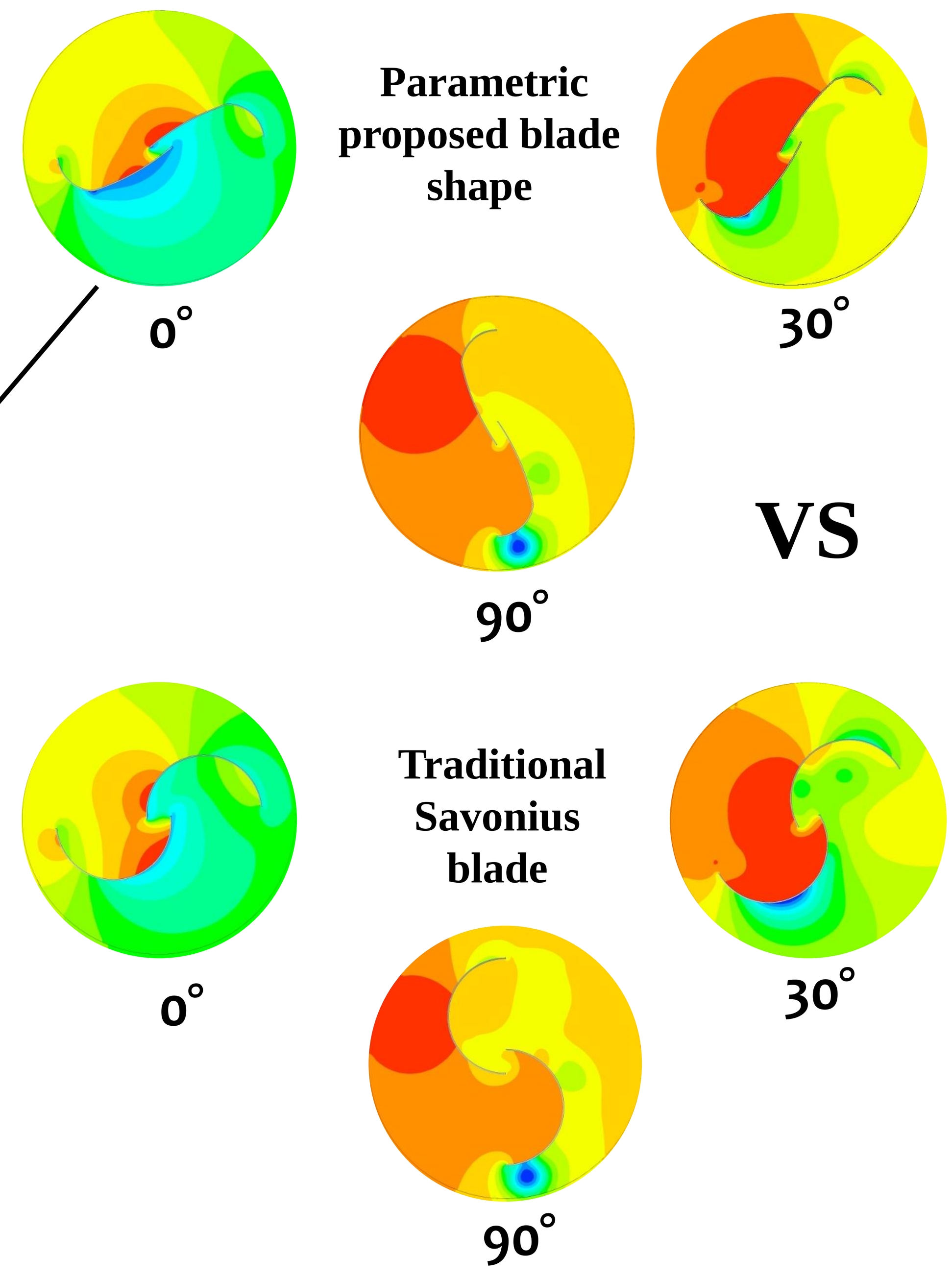


Figure 5. Moment coefficient at λ = 0.59 of six design shapes derived from proposed conjecture.



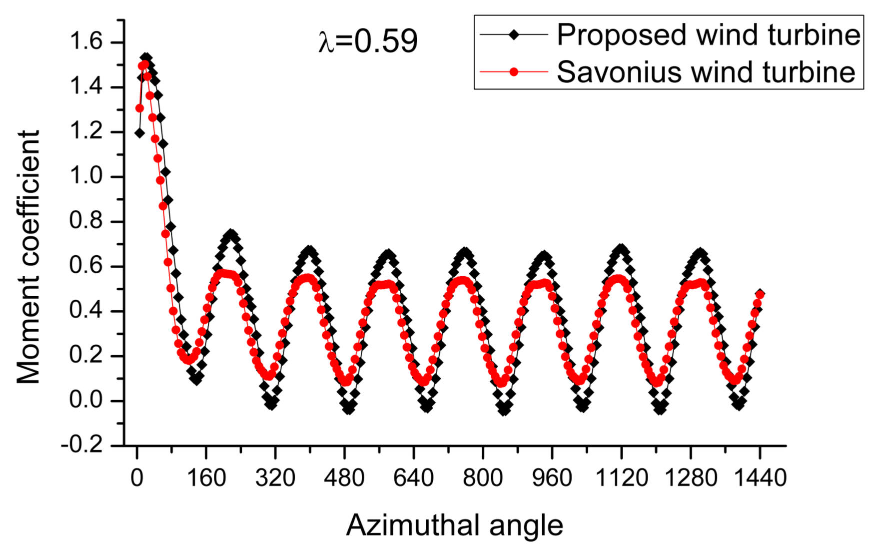


Figure 6. Moment coefficient comparison between Proposed and Savonius.

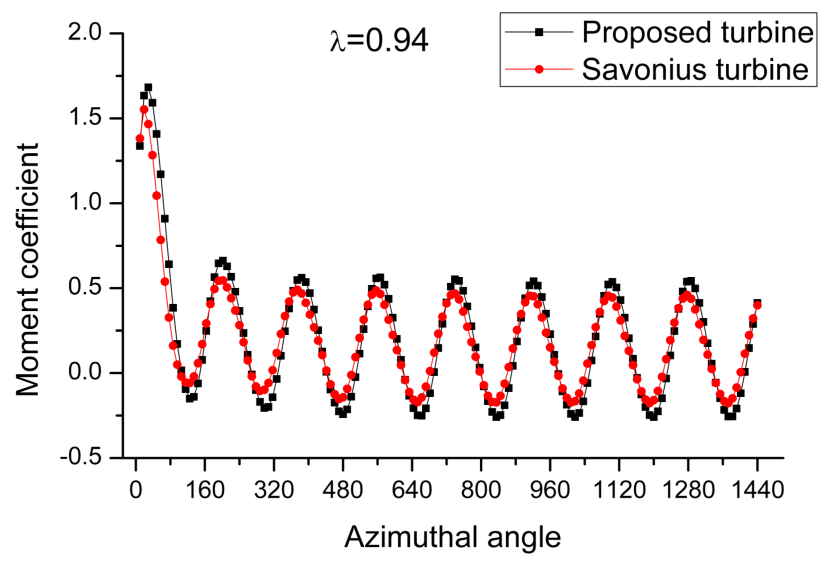


Figure 7. Moment coefficient comparison between Proposed and Savonius.

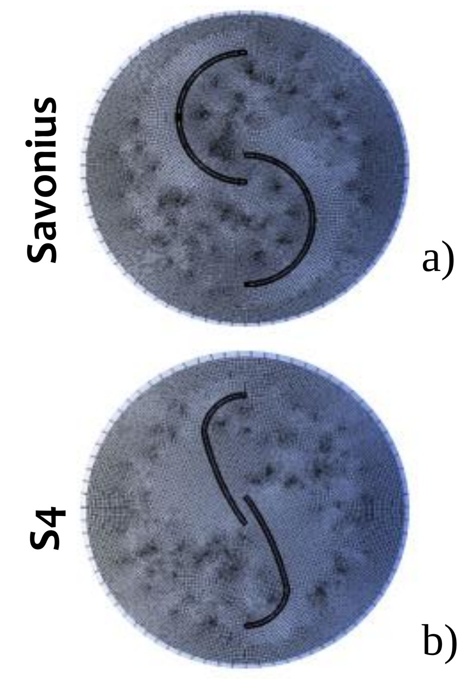


Figure 8. Dynamic domain grid topology: (a) Savonius, (b) Proposed shape (S4).

6. EXPERIMENTAL RESULTS

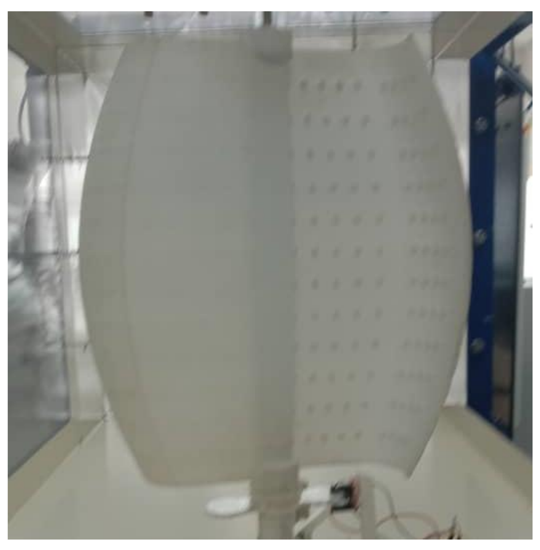


Figure 9. Prototype experimental setup.

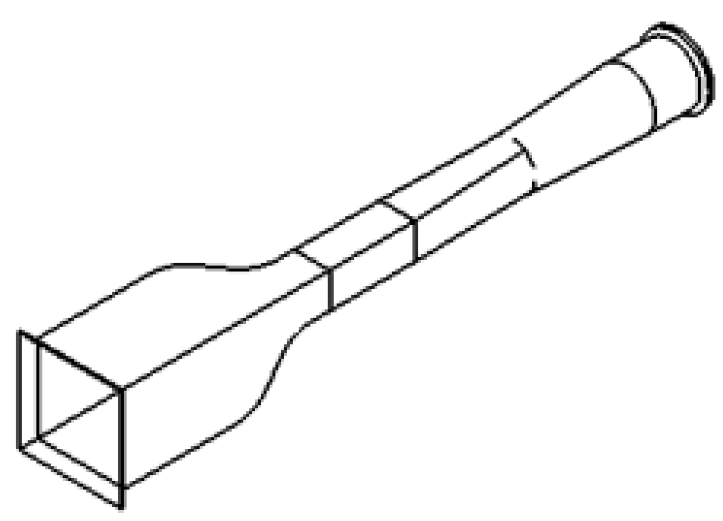


Figure 10. UMP wind tunnel configuration.

Figure 11. Computational representation proposed design.

Table 1. Average moment coefficient of proposed shape and Savonius at λ = 0.59.

Wind turbine configuration	Experimental Procedure (C_m)	CFD numerical solver (C_m)	Percentage of error (%)
Savonius	0.383184	0.375023	2.1
Proposed configuration	0.417519	0.401881	3.7

In this study, the geometries is analyzed via CFD simulation using FLUENT based on URANS and SST numerical model. The turbines were studied at λ = 0.59, under constant freestream velocity of 8 m/s. The result shows that design proposed shape displayed higher moment coefficient than Savonius wind turbine with an improvement of 7.2% in moment coefficient at λ = 0.59. It is proven that, blade morphology derived from the proposed conjecture and barnacle system improves the moment coefficient of the turbine.

7. NOVELTY

1. Bio-adaptation coupled with hybridization technique for the construction of wind turbine blade morphology.
2. Numerical conjecture $(\sqrt{2}+2)$ for parametric alteration of respective wind turbine blade morphology.

8. STATUS OF INNOVATION/MARKETABILITY

1. The presented innovation is at prototyping stage as for further refinement and optimization
2. Potential collaboration in the future with renewable energy related companies and patent application via UMP.

9. ACHIEVEMENT

1. **Silver** in Creation, Innovation, Technology & Research Exposition (Citrex 2019), Novel bio-inspired hybrid vertical axis wind turbine, UMP.
2. **Bronze** in Creation, Innovation, Technology & Research Exposition (Citrex 2020), A novel Savonius wind turbine, UMP.

10. PUBLICATIONS (Scopus indexing)

1. **S. N. Ashwindran**, A. A. Azizuddin, & A. N. Oumer. (2021). A review on the prospect of wind power as an alternative source of energy in Malaysia. *IOP Conference Series: Materials Science and Engineering. Vol 1078.*
2. **S. N. Ashwindran**, A. A. Azizuddin, & A. N. Oumer. (2020). An introductory CFD analysis study of novel cavity vane driven wind turbine blade design. *Journal of Mechanical Engineering, Vol 17(3), 55-68.*
3. **S. N. Ashwindran**, A. A. Azizuddin, & A. N. Oumer. (2020) Real time CFD flow response visualization and interaction app based on augmented reality. *Journal of Information and Communication Technology. Vol 19(4), 559-581.*
4. **S. N. Ashwindran**, A. A. Azizuddin, & A. N. Oumer. (2020) Rudimentary computational assessment of low tip speed ratio asymmetrical wind turbine blades. *International Journal of Integrated Engineering. Vol 12(4), 89-103.*
5. **S. N. Ashwindran**, A. A. Azizuddin, & A. N. Oumer. (2020) A moment coefficient computational study of parametric drag-driven wind turbine at moderate tip speed ratios. *Australian Journal of Mechanical Engineering.*
6. **S. N. Ashwindran**, A. A. Azizuddin, & A. N. Oumer. (2020) Comparative power extraction analysis of novel nature inspired vertical axis wind turbines. UTP-UMP-UAF Symposium on Energy Systems 2019. *Vol 863.*
7. **S. N. Ashwindran**, A. A. Azizuddin, & A. N. Oumer. (2019). Unsteady Computational Study of Novel Biologically Inspired Offshore Vertical Axis Wind Turbine at Different Tip Speed Ratios: A Two-Dimensional Study. *International Journal of Automotive and Mechanical Engineering, Vol 16(2), 6753-6772.*
8. **S. N. Ashwindran**, A. A. Azizuddin, & A. N. Oumer. (2019). Computational Fluid Dynamic (CFD) Of Vertical-Axis Wind Turbine: Mesh and Time-Step Sensitivity Study. *Journal of Mechanical Engineering and Sciences. Vol 13(3), 5604-5624.*